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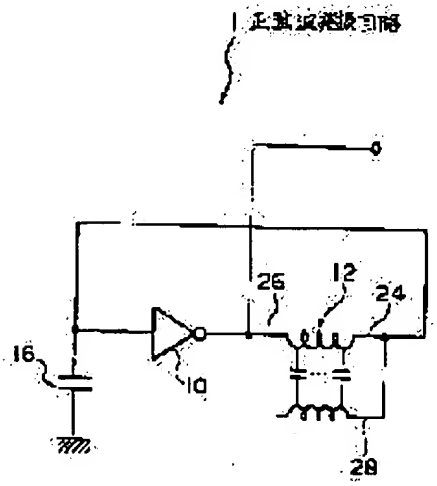
(54) SINE WAVE OSCILLATION CIRCUIT



(57)Abstract:
PURPOSE: To provide a sine wave oscillation circuit capable of combining less kinds of parts, easily generating sine waves and being integrally formed on a semiconductor substrate.
CONSTITUTION: This sine wave oscillation circuit 1 is provided with an inverter logic circuit 10 functioning as an invertible amplifier and an LC element 12 formed on the semiconductor substrate. The LC element 12 is provided with first and second spiral electrodes approximately concentrically and approximately parallelly formed on the semiconductor substrate and a spiral pn joined layer for which a (p) area and an (n) area are connected to the respective electrodes. The respective electrodes function as inductor conductors and a distribution constant type capacitor by the pn joined layer is formed between the respective inductor conductors. In such a manner, the respective components of the sine wave oscillation circuit 1 are formed on the semiconductor substrate and the whole is integrally formed.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.
CLAIMS

[Claim(s)]
[Claim 1] Almost in parallel to the semiconductor substrate top, it is formed with the inverting amplifier which performs phase inversion while amplifying an input signal. It has a conductor. each two inductors for which either is used as a signal I/O way while connecting near the edge electrically on the other hand -- these two inductors -- two inductors by the conductor and the capacitor between them with LC element currently formed in distributed constant ******, the sinusoidal oscillator circuit characterized by performing a sinusoidal oscillation when while functioning as a signal I/O way of the aforementioned LC element returns the output of the aforementioned inverting amplifier to an input side through an inductor.
[Claim 2] The sinusoidal oscillator circuit characterized by constituting the aforementioned inverting amplifier by the inverter logical circuit in a claim 1.
[Claim 3] The sinusoidal oscillator circuit characterized by constituting the aforementioned inverting amplifier by the grounded-source circuit or the grounded emitter circuit in a claim 1.
[Claim 4] Either of the claims 1-3 which is characterized by providing the following. within the same flat surface, mostly, by the shape of the said heart, the aforementioned LC element adjoins and is arranged -- having -- **** -- two aforementioned inductors -- spiral shape-like two electrodes which function as a conductor The pn junction layer of the shape of spiral shape which operates as the aforementioned capacitor by being formed in the position which is near the front face of the aforementioned semiconductor substrate, and met the two aforementioned electrodes, connecting p field to either of these two electrodes, connecting n field to another side electrically, and impressing reverse bias voltage.
[Claim 5] Either of the claims 1-3 which is characterized by providing the following. on both sides of the aforementioned semiconductor substrate, the aforementioned LC element counters mostly and is arranged -- having -- **** -- two aforementioned inductors -- spiral shape-like two electrodes which function as a conductor The pn junction layer of the shape of spiral shape which operates as the aforementioned capacitor by being formed in the position which is in the aforementioned semiconductor substrate and was inserted into the two aforementioned electrodes, connecting p field to either of these two electrodes, connecting n field to another side electrically, and impressing reverse bias voltage.
[Claim 6] Either of the claims 1-3 which is characterized by providing the following. within the same flat surface, the aforementioned LC element adjoins parallel mostly and is arranged -- having -- **** -- two aforementioned inductors -- two electrodes of a meandering configuration which function as a conductor The pn junction layer of the meandering configuration which operates as the aforementioned capacitor by being formed in the position which is near the front face of the aforementioned semiconductor substrate, and met the two aforementioned electrodes, connecting p field to either of these two electrodes, connecting n field to another side electrically, and impressing reverse bias voltage.
[Claim 7] Either of the claims 1-3 which is characterized by providing the following. on both

sides of the aforementioned semiconductor substrate, the aforementioned LC element counters and is arranged -- having -- **** -- two aforementioned inductors -- two electrodes of a meandering configuration which function as a conductor The pn junction layer of the shape of spiral shape which operates as the aforementioned capacitor by being formed in the position which is in the aforementioned semiconductor substrate and was inserted into the two aforementioned electrodes, connecting p field to either of these two electrodes, connecting n field to another side electrically, and impressing reverse bias voltage.

[Claim 8] The sinusoidal oscillator circuit characterized by forming one length of the two aforementioned electrodes short compared with another side in either of the claims 4-7.

[Claim 9] The sinusoidal oscillator circuit characterized by dividing into plurality the aforementioned pn junction layer which corresponds with one side of the two aforementioned electrodes which divide into plurality one side of the two aforementioned electrodes which function as an inductor of aforementioned another side in either of the claims 4-8, or function as an inductor of aforementioned another side, and connecting a part of each piece of division mutually.

[Claim 10] The sinusoidal oscillator circuit characterized by changing the capacity value of the capacitor formed in distributed constant in the aforementioned LC element by changing the reverse bias voltage impressed to the aforementioned pn junction layer in either of the claims 4-9.

[Claim 11] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the electrode of the shape of spiral shape which forms the gate in an MOS structure, the electrode of the shape of aforementioned spiral shape, and the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the electrode of the shape of aforementioned spiral shape, and functions as the source and a drain, and the 2nd diffusion field, the electrode of ****** and the shape of aforementioned spiral shape, and each of the channel formed corresponding to this -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the aforementioned channel as the aforementioned signal I/O way while functioning as a conductor

[Claim 12] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the electrode of the shape of spiral shape which forms the gate in an MOS structure, the electrode of the shape of aforementioned spiral shape, and the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the electrode of the shape of aforementioned spiral shape which is formed near an edge on the other hand, and functions as the source or a drain, the electrode of ****** and the shape of aforementioned spiral shape, and each of the channel formed corresponding to this -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the electrode of the shape of aforementioned spiral shape as the aforementioned signal I/O way while functioning as a conductor

[Claim 13] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the electrode of the meandering configuration which forms the gate in an MOS structure, the electrode of the aforementioned meandering configuration, and the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the electrode of the aforementioned meandering configuration, and functions as the source and a drain, and the 2nd diffusion field, the electrode of ****** and the aforementioned meandering configuration, and each of the channel formed corresponding to this -- two aforementioned inductors -- if it functions as a

conductor -- being also alike -- the sinusoidal oscillator circuit characterized by using the aforementioned channel as the aforementioned signal I/O way
[Claim 14] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the electrode of the meandering configuration which forms the gate in an MOS structure, the electrode of the aforementioned meandering configuration, and the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the electrode of the aforementioned meandering configuration which is formed near an edge on the other hand, and functions as the source or a drain, the electrode of ****** and the aforementioned meandering configuration, and each of the channel formed corresponding to this -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- the sinusoidal oscillator circuit characterized by using the electrode of the aforementioned meandering configuration as the aforementioned signal I/O way
[Claim 15] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the 1st electrode of the shape of spiral shape which forms the gate in an MOS structure, the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape which is the aforementioned semiconductor substrate front face, and was adjoined and formed by the shape of the 1st electrode of the above, and the said heart, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the spiral shape-like 1st electrode of the above, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- the sinusoidal oscillator circuit characterized by using the aforementioned channel as the aforementioned signal I/O way
[Claim 16] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the 1st electrode of the shape of spiral shape which forms the gate in an MOS structure, the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape which is the aforementioned semiconductor substrate front face, and was adjoined and formed by the shape of the 1st electrode of the above, and the said heart, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the spiral shape-like 1st electrode of the above which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- the sinusoidal oscillator circuit characterized by using the 2nd electrode of the above as the aforementioned signal I/O way
[Claim 17] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the 1st electrode of the meandering configuration which forms the gate in an MOS structure, the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration which is the aforementioned semiconductor substrate front face, and was mostly adjoined and formed in parallel along with the 1st electrode of the above, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the 1st electrode of the above of a meandering configuration, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to

the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the aforementioned channel as the aforementioned signal I/O way while functioning as a conductor

[Claim 18] In either of the claims 1-3 the aforementioned LC element The insulating layer formed between the 1st electrode of the meandering configuration which forms the gate in an MOS structure, the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration which is the aforementioned semiconductor substrate front face, and was mostly adjoined and formed in parallel along with the 1st electrode of the above, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the 1st electrode of the above of a meandering configuration which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the 2nd electrode of the above as the aforementioned signal I/O way while functioning as a conductor

[Claim 19] In either of the claims 1-3 the aforementioned LC element The 1st electrode of the shape of spiral shape which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the spiral shape-like 1st electrode of the above, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the aforementioned channel as the aforementioned signal I/O way while functioning as a conductor

[Claim 20] In either of the claims 1-3 the aforementioned LC element The 1st electrode of the shape of spiral shape which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the spiral shape-like 1st electrode of the above which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the 2nd electrode of the above as the aforementioned signal I/O way while functioning as a conductor

[Claim 21] In either of the claims 1-3 the aforementioned LC element The 1st electrode of the meandering configuration which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the 1st

electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the 1st electrode of the above of a meandering configuration, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the aforementioned channel as a signal I/O way while functioning as a conductor

[Claim 22] In either of the claims 1-3 the aforementioned LC element The 1st electrode of the meandering configuration which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the 1st electrode of the above of a meandering configuration which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by using the 2nd electrode of the above as a signal I/O way while functioning as a conductor

[Claim 23] The sinusoidal oscillator circuit characterized by to make the aforementioned electrode and the aforementioned channel of the shape of spiral shape, and a meandering configuration counter partially by [of the position in which it is near / aforementioned / the semiconductor substrate front face, and the aforementioned channel is formed in either of the claims 11-14] setting up the length of the aforementioned channel for a long time or short to the electrode of the aforementioned shape of spiral shape, and the aforementioned meandering configuration while pouring in a carrier beforehand in part at least.

[Claim 24] The sinusoidal oscillator circuit characterized by making the 2nd electrode of the above and the aforementioned channel of the shape of spiral shape, and a meandering configuration counter partially in either of the claims 15-22 by forming short the length of either the above 1st and the 2nd electrode compared with another side.

[Claim 25] claim 11- the sinusoidal oscillator circuit characterized by pouring a carrier into the position in which it is near [aforementioned] the semiconductor substrate front face, and the aforementioned channel is formed in 22 or 24 beforehand

[Claim 26] [when using the aforementioned channel formed corresponding to the 1st electrode of the above as an inductor of aforementioned another side in either of the claims 16, 18, 20, 22, 24, and 25] The sinusoidal oscillator circuit characterized by dividing into plurality the aforementioned channel formed by dividing the 1st electrode of the above into plurality corresponding to the 1st electrode of the above, and connecting mutually the aforementioned diffusion field of each division channel formed near the edge on the other hand.

[Claim 27] The sinusoidal oscillator circuit characterized by dividing the 2nd electrode of the above into plurality in either of the claims 15, 17, 19, 21, 24, and 25 when using the 2nd electrode of the above as an inductor of aforementioned another side, and connecting a part of

each piece of a division electrode mutually.
[Claim 28] The sinusoidal oscillator circuit characterized by controlling to adjustable the resistance which the aforementioned channel has by changing the gate voltage impressed to the electrode which forms the aforementioned gate in either of the claims 11-27.
[Claim 29] In either of the claims 1-3 the aforementioned LC element The 1st electrode of the shape of spiral shape formed in the aforementioned semiconductor front face on both sides of direct or the 1st insulating layer, The 2nd insulating layer formed in the front face of the 1st electrode of the above, and the 1st electrode of the above and the 2nd electrode of the shape of spiral shape formed in the position which counters mostly on both sides of the 2nd insulating layer of the above, each of ******, the above 1st, and the 2nd electrode -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by functioning as a conductor
[Claim 30] In either of the claims 1-3 the aforementioned LC element The 1st electrode of the meandering configuration formed in the aforementioned semiconductor front face on both sides of direct or the 1st insulating layer, The 2nd insulating layer formed in the front face of the 1st electrode of the above, and the 1st electrode of the above and the 2nd electrode of the meandering configuration formed in the position which counters mostly on both sides of the 2nd insulating layer of the above, each of ******, the above 1st, and the 2nd electrode -- two aforementioned inductors -- the sinusoidal oscillator circuit characterized by functioning as a conductor
[Claim 31] It is the sinusoidal oscillator circuit characterized by being the oxide film formed when the 2nd insulating layer of the above oxidized the 1st electrode of the above in claims 29 or 30.
[Claim 32] It is the sinusoidal oscillator circuit characterized by being the semiconductor oxide film or nitride in which the 2nd insulating layer of the above was formed by the chemistry gaseous-phase method in claims 29 or 30.
[Claim 33] The sinusoidal oscillator circuit characterized by forming short the length of either the above 1st and the 2nd electrode compared with another side in either of the claims 29-32.
[Claim 34] The sinusoidal oscillator circuit characterized by dividing into plurality either the above 1st which functions as an inductor of aforementioned another side, or the 2nd electrode in either of the claims 29-33, and connecting a part of each piece of division mutually.
[Claim 35] The sinusoidal oscillator circuit characterized by really forming the aforementioned LC element and the aforementioned inverting amplifier on the common aforementioned semiconductor substrate in either of the claims 1-34.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the sinusoidal oscillator circuit which acquires the sinusoidal signal of predetermined frequency using LC resonance.
[0002]
[Description of the Prior Art] From the former, the sine wave is used in various fields, such as communication, and the thing various also in the oscillator circuit which acquires this sine wave is known. For example, various LC oscillator circuits, such as the Colpitts type and a Hartley type, are known as a typical circuit which can acquire the sine wave of a RF.

[0003] These various LC oscillator circuits are theoretically constituted by each combining amplifier and LC circuits, such as a transistor, and in order to acquire the sine wave of desired oscillation frequency, they need to determine each element constant.
[0004]
[Problem(s) to be Solved by the Invention] By the way, since the conventional sinusoidal oscillator circuit prepared individually the inductor and capacitor which constitute LC circuit and had combined them, while the flexibility of a design increases, there are many element constants which a designer etc. determines and a design becomes complicated. It is convenient if it can have desired oscillation frequency easily only by combining the parts of a fewer kind especially depending on the equipment which uses a sine wave.
[0005] Moreover, as for the inductor which constitutes LC circuit, a core and a bobbin have many which give a coil, and, generally it is unsuitable for integration. Even if it was the case where it was going to IC-ize the sinusoidal whole oscillator circuit including LC circuit, only the inductor's having un-arranged [that it must carry out external] and had the problem that the whole circuit could not really be formed on a semiconductor substrate.
[0006] this invention is created in view of such a point, and is for the purpose to offer the sinusoidal oscillator circuit which can generate a sine wave simply combining the parts of a fewer kind.
[0007] Moreover, other purposes of this invention are about the whole circuit to offer the sinusoidal oscillator circuit which can really be formed on a semiconductor substrate.
[0008]
[Means for Solving the Problem] In order to solve the technical problem mentioned above, the sinusoidal oscillator circuit of a claim 1 Almost in parallel to the semiconductor substrate top, it is formed with the inverting amplifier which performs phase inversion while amplifying an input signal. It has a conductor. each two inductors for which either is used as a signal I/O way while connecting near the edge electrically on the other hand -- these two inductors -- two inductors by the conductor and the capacitor between them with LC element currently formed in distributed constant When while functioning as a signal I/O way of the aforementioned LC element returns the output of ****** and the aforementioned inverting amplifier to an input side through an inductor, it is characterized by performing a sinusoidal oscillation.
[0009] The sinusoidal oscillator circuit of a claim 2 is characterized by constituting the aforementioned inverting amplifier by the inverter logical circuit in the sinusoidal oscillator circuit of a claim 1.
[0010] The sinusoidal oscillator circuit of a claim 3 is characterized by constituting the aforementioned inverting amplifier by the grounded-source circuit or the grounded emitter circuit in the sinusoidal oscillator circuit of a claim 1.
[0011] The sinusoidal oscillator circuit of a claim 4 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element it arranges adjacently by the shape of the said heart mostly within the same flat surface -- having -- **** -- two aforementioned inductors -- with spiral shape-like two electrodes which function as a conductor It is formed in the position which is near the front face of the aforementioned semiconductor substrate, and met the two aforementioned electrodes. p field is connected to either of these two electrodes, n field is electrically connected to another side, and it is characterized by having the pn junction layer of the shape of spiral shape which operates as the aforementioned capacitor by impressing reverse bias voltage.
[0012] The sinusoidal oscillator circuit of a claim 5 is set to one sinusoidal oscillator circuit of

the claims 1-3. the aforementioned LC element on both sides of the aforementioned semiconductor substrate, it counters mostly and arranges -- having -- **** -- two aforementioned inductors -- with spiral shape-like two electrodes which function as a conductor It is formed in the position which is in the aforementioned semiconductor substrate and was inserted into the two aforementioned electrodes. p field is connected to either of these two electrodes, n field is electrically connected to another side, and it is characterized by having the pn junction layer of the shape of spiral shape which operates as the aforementioned capacitor by impressing reverse bias voltage.

[0013] The sinusoidal oscillator circuit of a claim 6 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element within the same flat surface, parallel are adjoined mostly and it arranges -- having -- **** -- two aforementioned inductors -- with two electrodes of a meandering configuration which function as a conductor It is formed in the position which is near the front face of the aforementioned semiconductor substrate, and met the two aforementioned electrodes. p field is connected to either of these two electrodes, n field is electrically connected to another side, and it is characterized by having the pn junction layer of the meandering configuration which operates as the aforementioned capacitor by impressing reverse bias voltage.

[0014] The sinusoidal oscillator circuit of a claim 7 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element on both sides of the aforementioned semiconductor substrate, it arranges face to face -- having -- **** -- two aforementioned inductors -- with two electrodes of a meandering configuration which function as a conductor It is formed in the position which is in the aforementioned semiconductor substrate and was inserted into the two aforementioned electrodes. p field is connected to either of these two electrodes, n field is electrically connected to another side, and it is characterized by having the pn junction layer of the shape of spiral shape which operates as the aforementioned capacitor by impressing reverse bias voltage.

[0015] The sinusoidal oscillator circuit of a claim 8 is characterized by forming one length of the two aforementioned electrodes short compared with another side in one sinusoidal oscillator circuit of the claims 4-7.

[0016] In one sinusoidal oscillator circuit of the claims 4-8, the sinusoidal oscillator circuit of a claim 9 divides into plurality the aforementioned pn junction layer which corresponds with one side of the two aforementioned electrodes which divide into plurality one side of the two aforementioned electrodes which function as an inductor of aforementioned another side, or function as an inductor of aforementioned another side, and is characterized by connecting a part of each piece of division mutually.

[0017] The sinusoidal oscillator circuit of a claim 10 is characterized by changing the capacity value of the capacitor formed in distributed constant in the aforementioned LC element in one sinusoidal oscillator circuit of the claims 4-9 by changing the reverse bias voltage impressed to the aforementioned pn junction layer.

[0018] The sinusoidal oscillator circuit of a claim 11 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the electrode of the shape of spiral shape which forms the gate in an MOS structure, the electrode of the shape of aforementioned spiral shape, and the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the electrode of the shape of aforementioned spiral shape, and functions as the source and a drain, and the 2nd diffusion field, the electrode of ****** and the

shape of aforementioned spiral shape, and each of the channel formed corresponding to this -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the aforementioned channel as the aforementioned signal I/O way

[0019] The sinusoidal oscillator circuit of a claim 12 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the electrode of the shape of spiral shape which forms the gate in an MOS structure, the electrode of the shape of aforementioned spiral shape, and the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the electrode of the shape of aforementioned spiral shape which is formed near an edge on the other hand, and functions as the source or a drain, the electrode of ****** and the shape of aforementioned spiral shape, and each of the channel formed corresponding to this -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the electrode of the shape of aforementioned spiral shape as the aforementioned signal I/O way

[0020] The sinusoidal oscillator circuit of a claim 13 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the electrode of the meandering configuration which forms the gate in an MOS structure, the electrode of the aforementioned meandering configuration, and the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the electrode of the aforementioned meandering configuration, and functions as the source and a drain, and the 2nd diffusion field, the electrode of ****** and the aforementioned meandering configuration, and each of the channel formed corresponding to this -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- it is characterized by using the aforementioned channel as the aforementioned signal I/O way

[0021] The sinusoidal oscillator circuit of a claim 14 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the electrode of the meandering configuration which forms the gate in an MOS structure, the electrode of the aforementioned meandering configuration, and the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the electrode of the aforementioned meandering configuration which is formed near an edge on the other hand, and functions as the source or a drain, the electrode of ****** and the aforementioned meandering configuration, and each of the channel formed corresponding to this -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- it is characterized by using the electrode of the aforementioned meandering configuration as the aforementioned signal I/O way

[0022] The sinusoidal oscillator circuit of a claim 15 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the 1st electrode of the shape of spiral shape which forms the gate in an MOS structure, the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape which is the aforementioned semiconductor substrate front face, and was adjoined and formed by the shape of the 1st electrode of the above, and the said heart, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the spiral shape-like 1st electrode of the above, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the

2nd electrode of the above -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- it is characterized by using the aforementioned channel as the aforementioned signal I/O way

[0023] The sinusoidal oscillator circuit of a claim 16 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the 1st electrode of the shape of spiral shape which forms the gate in an MOS structure, the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape which is the aforementioned semiconductor substrate front face, and was adjoined and formed by the shape of the 1st electrode of the above, and the said heart, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the spiral shape-like 1st electrode of the above which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- if it functions as a conductor -- being also alike -- it is characterized by using the 2nd electrode of the above as the aforementioned signal I/O way

[0024] The sinusoidal oscillator circuit of a claim 17 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the 1st electrode of the meandering configuration which forms the gate in an MOS structure, the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration which is the aforementioned semiconductor substrate front face, and was mostly adjoined and formed in parallel along with the 1st electrode of the above, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the 1st electrode of the above of a meandering configuration, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the aforementioned channel as the aforementioned signal I/O way

[0025] The sinusoidal oscillator circuit of a claim 18 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The insulating layer formed between the 1st electrode of the meandering configuration which forms the gate in an MOS structure, the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration which is the aforementioned semiconductor substrate front face, and was mostly adjoined and formed in parallel along with the 1st electrode of the above, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the 1st electrode of the above of a meandering configuration which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the 2nd electrode of the above as the aforementioned signal I/O way

[0026] The sinusoidal oscillator circuit of a claim 19 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The 1st electrode of the shape of spiral shape which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the spiral shape-like 1st electrode

of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the spiral shape-like 1st electrode of the above, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the aforementioned channel as the aforementioned signal I/O way

[0027] The sinusoidal oscillator circuit of a claim 20 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The 1st electrode of the shape of spiral shape which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the spiral shape-like 1st electrode of the above, and the aforementioned semiconductor substrate, The 2nd electrode of the shape of spiral shape formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the spiral shape-like 1st electrode of the above which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of the shape of ****** and spiral shape, and the 2nd electrode of the above -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the 2nd electrode of the above as the aforementioned signal I/O way

[0028] The sinusoidal oscillator circuit of a claim 21 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The 1st electrode of the meandering configuration which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st which is in the aforementioned semiconductor substrate, is formed near the ends of the channel formed corresponding to the 1st electrode of the above of a meandering configuration, and functions as the source and a drain, and the 2nd diffusion field, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the aforementioned channel as a signal I/O way

[0029] The sinusoidal oscillator circuit of a claim 22 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The 1st electrode of the meandering configuration which is formed in one field side of the aforementioned semiconductor substrate, and forms the gate in an MOS structure, The insulating layer formed between the 1st electrode of the above of a meandering configuration, and the aforementioned semiconductor substrate, The 2nd electrode of the meandering configuration formed in the 1st electrode of the above, and the position which counters mostly by being formed in the field side of another side of the aforementioned semiconductor substrate, The 1st diffusion field of the channel which is in the aforementioned semiconductor substrate and is formed corresponding to the 1st electrode of the

above of a meandering configuration which is formed near an edge on the other hand, and functions as the source or a drain, each of the channel formed corresponding to the 1st electrode of the above of ****** and a meandering configuration, and the 2nd electrode of the above -- two aforementioned inductors -- while functioning as a conductor, it is characterized by using the 2nd electrode of the above as a signal I/O way

[0030] While the position in which it is near [aforementioned] the semiconductor substrate front face, and the aforementioned channel is formed in one sinusoidal oscillator circuit of the claims 11-14 boils the sinusoidal oscillator circuit of a claim 23 in part at least and pouring in a carrier beforehand By setting up the length of the aforementioned channel for a long time or short to the electrode of the aforementioned shape of spiral shape, and the aforementioned meandering configuration, it is characterized by making the aforementioned electrode and the aforementioned channel of the shape of spiral shape, and a meandering configuration counter partially.

[0031] The sinusoidal oscillator circuit of a claim 24 is characterized by making the 2nd electrode of the above and the aforementioned channel of the shape of spiral shape, and a meandering configuration counter partially in one sinusoidal oscillator circuit of the claims 15-22 by forming short the length of either the above 1st and the 2nd electrode compared with another side.

[0032] the sinusoidal oscillator circuit of a claim 25 -- claim 11- in the sinusoidal oscillator circuit of 22 or 24, it is characterized by pouring a carrier into the position in which it is near [aforementioned] the semiconductor substrate front face, and the aforementioned channel is formed beforehand

[0033] The sinusoidal oscillator circuit of a claim 26 is set to one sinusoidal oscillator circuit of the claims 16, 18, 20, 22, 24, and 25. [when using the aforementioned channel formed corresponding to the 1st electrode of the above as an inductor of aforementioned another side] By dividing the 1st electrode of the above into plurality, the aforementioned channel formed corresponding to the 1st electrode of the above is divided into plurality, and it is characterized by connecting mutually the aforementioned diffusion fields of each division channel formed near the edge on the other hand.

[0034] In one sinusoidal oscillator circuit of the claims 15, 17, 19, 21, 24, and 25, the sinusoidal oscillator circuit of a claim 27 divides the 2nd electrode of the above into plurality, when using the 2nd electrode of the above as an inductor of aforementioned another side, and it is characterized by connecting a part of each piece of a division electrode mutually.

[0035] The sinusoidal oscillator circuit of a claim 28 is characterized by controlling to adjustable the resistance which the aforementioned channel has in one sinusoidal oscillator circuit of the claims 11-27 by changing the gate voltage impressed to the electrode which forms the aforementioned gate.

[0036] The sinusoidal oscillator circuit of a claim 29 is set to one sinusoidal oscillator circuit of the claims 1-3. the aforementioned LC element The 1st electrode of the shape of spiral shape formed in the aforementioned semiconductor front face on both sides of direct or the 1st insulating layer, The 2nd insulating layer formed in the front face of the 1st electrode of the above, and the 1st electrode of the above and the 2nd electrode of the shape of spiral shape formed in the position which counters mostly on both sides of the 2nd insulating layer of the above, each of ******, the above 1st, and the 2nd electrode -- two aforementioned inductors -- it is characterized by functioning as a conductor

[0037] The sinusoidal oscillator circuit of a claim 30 is set to one sinusoidal oscillator circuit of

the claims 1-3. the aforementioned LC element The 1st electrode of the meandering configuration formed in the aforementioned semiconductor front face on both sides of direct or the 1st insulating layer, the 2nd insulating layer formed in the front face of the 1st electrode of the above, and the 1st electrode of the above and the 2nd electrode of the meandering configuration formed in the position which counters mostly on both sides of the 2nd insulating layer of the above -- having -- each of the above 1st and the 2nd electrode -- two aforementioned inductors -- it is characterized by functioning as a conductor

[0038] The sinusoidal oscillator circuit of a claim 31 is characterized by the 2nd insulating layer of the above being the oxide film formed by oxidizing the 1st electrode of the above in the sinusoidal oscillator circuit of claims 29 or 30.

[0039] The sinusoidal oscillator circuit of a claim 32 is characterized by the 2nd insulating layer of the above being the semiconductor oxide film or nitride formed by the chemistry gaseous-phase method in the sinusoidal oscillator circuit of claims 29 or 30.

[0040] The sinusoidal oscillator circuit of a claim 33 is characterized by forming short the length of either the above 1st and the 2nd electrode compared with another side in one sinusoidal oscillator circuit of the claims 29-32.

[0041] In one sinusoidal oscillator circuit of the claims 29-33, the sinusoidal oscillator circuit of a claim 34 divides into plurality either the above 1st which functions as an inductor of aforementioned another side, or the 2nd electrode, and is characterized by connecting a part of each piece of division mutually.

[0042] The sinusoidal oscillator circuit of a claim 35 is characterized by really forming the aforementioned LC element and the aforementioned inverting amplifier on the common aforementioned semiconductor substrate in one sinusoidal oscillator circuit of the claims 1-34.

[0043]

[Function] The sinusoidal oscillator circuit of a claim 1 is constituted by connecting an inverting amplifier and LC element in the shape of a ring. If its attention is paid only to the phase of a signal, in LC element, a phase will shift 180 degrees, and an oscillation will be performed on frequency whose phase of the signal which a phase shifts 180 degrees, and takes a round with the phase of the signal outputted, and returns by the inverting amplifier further corresponds. And LC element mentioned above can connect the one side edges of two inductors mutually, and can treat them as a single 2 terminal element, and the handling of parts becomes easy.

[0044] Thus, according to invention of a claim 1, the sinusoidal oscillation is performed only by connecting an inverting amplifier and LC element, and a sine wave can be easily generated only by combining the parts of a fewer kind.

[0045] Furthermore, since LC element mentioned above is formed on the semiconductor substrate, it is possible to form all the parts containing an inverting amplifier on a semiconductor substrate, and the mass production method and the miniaturization of a circuit using the semiconductor manufacturing technology of it are attained. Since especially these each part article can also be formed on one semiconductor substrate and the whole circuit will really be formed on a semiconductor substrate in this case, mass production method and the miniaturization of a circuit become still easier.

[0046] Moreover, the sinusoidal oscillator circuit of claims 2 or 3 constitutes the inverting amplifier mentioned above by the grounded-source circuit or grounded emitter circuit using the inverter logical circuit or the transistor. That is, while reversing the logic of an input signal and outputting, the voltage level of an input signal can be amplified, such structure can only combine a simple inverting amplifier and LC element, and each of these can generate a sine wave simply.

Generally, especially the inverter logical circuit, grounded-source circuit, or grounded emitter circuit mentioned above becomes still more convenient, when it is formed on a semiconductor substrate and really forms with other parts.

[0047] The sinusoidal oscillator circuit of claims 4-7 shows the 1st example which showed the concrete composition of LC element used by the claims 1-3 mentioned above.

[0048] According to invention of a claim 4, LC element mentioned above by the pn junction layer of the shape of spiral shape formed along with two electrodes which were on the semiconductor substrate, adjoined in the shape of the said heart, and have been arranged, and these two electrodes is formed. A spiral shape-like capacitor is formed by impressing reverse bias voltage to this pn junction layer. Therefore, the inductor which is alike, respectively and is formed more and this capacitor of two electrodes will be formed in distributed constant on a semiconductor substrate. Especially, since this LC element is formed in a semiconductor substrate using a semiconductor manufacturing technology, in case it really forms on a semiconductor substrate with the other parts, such as an inverting amplifier, it becomes convenient.

[0049] Moreover, according to invention of a claim 5, by carrying out opposite arrangement of the two electrodes of each other prepared in the shape of the said heart on the semiconductor substrate in the claim 4 on both sides of a semiconductor substrate, LC element will be formed and the inductor by each electrode and the capacitor by the pn junction layer in the meantime will be formed in distributed constant by this. Since this LC element is formed in a semiconductor substrate using a semiconductor manufacturing technology, in case it really forms with the other parts, such as an inverting amplifier, it becomes convenient. [as well as LC element of a claim 4]

[0050] Moreover, according to invention of claims 6 and 7, LC element is formed by transposing the electrode in claims 4 and 5 to a meandering configuration from the shape of spiral shape. Although it could be made to function as an inductor by forming a conductor in the shape of spiral shape generally, even when a conductor is made into a meandering configuration depending on the frequency band to be used, it can be made to function as an inductor. That is, since each of each concavo-convex sections becomes the coil of about 1/2 turn and these are connected in series when an electrode is formed in a meandering configuration, the whole electrode functions as an inductor which has a predetermined inductance. Since a small inductance is sufficient when the frequency of the signal used especially arrives at a RF field, the inductor of a meandering configuration may be sufficient.

[0051] When [of an electrode] an electrode is especially formed in a meandering configuration, and wiring an edge or ends on the other hand, there is an advantage which can pull out this wiring, without intersecting a part of electrode, and simplification of the manufacturing process of the sinusoidal whole oscillator circuit is attained.

[0052] moreover, the thing for which either of two electrodes is formed short according to invention of a claim 8 -- an inductor -- LC element which the conductor countered partially is formed Generally, since the oscillation frequency of the sinusoidal whole oscillator circuit is determined by the inductance and capacitance which were formed in distributed constant, if capacitance is made small by forming one electrode short, oscillation frequency will also be changed in connection with it. Therefore, the flexibility of a design of a sinusoidal oscillator circuit also becomes can adjust oscillation frequency in a certain range, and increases it by changing the rate of the electrode which carries out partial opposite etc.

[0053] moreover, the inductor which was divided by dividing the pn junction layer

corresponding to plurality for either of two electrodes into plurality with division or division of this electrode according to invention of a claim 9 -- LC element with little influence by the conductor is formed That is, since the self-inductance of each piece of a division electrode becomes small, the property of LC element will be mostly determined by the inductance which the electrode which is not divided has, and the capacitance formed in distributed constant. Therefore, the flexibility of a design of a sinusoidal oscillator circuit also becomes can adjust oscillation frequency in a certain range, and increases it by changing the division state of an electrode.

[0054] Moreover, according to invention of a claim 10, LC element which can change the capacity value of the capacitor formed in distributed constant is formed by changing the reverse bias voltage impressed to a pn junction layer. Generally, a pn junction layer operates as a variable capacitance diode by impressing adjustable reverse bias voltage. Therefore, by operating the whole region of the pn junction layer which controls the reverse bias voltage to impress to adjustable, and has the shape of spiral shape, and a meandering configuration as a variable capacitance diode, it can consider as LC element which can change the frequency characteristic in a certain range, and a sinusoidal armature-voltage control type oscillator circuit can be realized easily.

[0055] The sinusoidal oscillator circuit of claims 11-22 shows the 2nd example which showed the concrete composition of LC element used by the claims 1-3 mentioned above.

[0056] the channel which according to invention of claims 11-14 LC element of the MOS structure in which the gate has the shape of spiral shape and a meandering configuration is formed, and is formed corresponding to a gate electrode and this -- respectively -- an inductor -- while functioning as a conductor, the distributed constant-capacitor is formed among these Each of these LC elements can be manufactured only by changing the configuration of a mask etc. using the process which manufactures the usual MOS transistor, and in case it really forms on a semiconductor substrate with the other parts, such as an inverting amplifier, they become convenient. Since the sinusoidal whole oscillator circuit can be made into an MOS structure when an inverting amplifier also has an MOS structure especially (for example, when inverter logical circuits, such as an MOS transistor and CMOS, constitute), simplification of a manufacturing process and high-density-assembly-ization of each part article are attained, and when incorporating as a part of IC or LCI, it becomes convenient especially.

[0057] According to invention of claims 15-22, mostly, LC element of an MOS structure is formed in the gate electrode of each LC element of claims 11-14 mentioned above parallel or by preparing the 2nd electrode so that it may counter mostly, and the gate electrode is used independently for reverse bias impression. Therefore, the voltage impression to a gate electrode and transmission of the signal through a channel or the 2nd electrode can be separated, and the flexibility of a design increases.

[0058] Moreover, according to invention of a claim 23, LC element is formed by making the gate electrode and channel in claims 11-14 counter partially. A channel can be formed only in some [corresponding to a gate electrode] fields, when a predetermined gate voltage is generally impressed by [of the position in which this channel is formed beforehand] pouring in the carrier in part at least, although the channel was formed in the semiconductor substrate front face corresponding to a gate electrode.

[0059] Moreover, according to invention of a claim 24, LC element is formed by shortening either of two electrodes in claims 15-22, and making a channel and an electrode counter partially.

[0060] thus, the inductor formed of a channel or an electrode also in LC element which has an

MOS structure -- it is possible to make a conductor counter partially and the flexibility of a design of a sinusoidal oscillator circuit also becomes can adjust oscillation frequency in a certain range, and increases it by changing the rate which carries out partial opposite
[0061] Moreover, according to invention of a claim 25, by pouring the carrier into the position in which the channel mentioned above is formed beforehand, LC element is formed and it has become LC element which has a DEPURESHON type MOS structure. Since channel resistance and the current between source drains are changeable by adjusting the amount of the carrier poured in especially beforehand, the flexibility of a design of a sinusoidal oscillator circuit also becomes can adjust the property of LC element in a certain range, and increases it.
[0062] Moreover, when using the 2nd electrode mentioned above as a signalling channel according to invention of a claim 26, LC element into which the channel which corresponds by dividing a gate electrode into plurality was divided is formed, and the property of LC element will be mostly determined by the inductance which the 2nd electrode which is not divided has, and the capacitance formed in distributed constant. Therefore, the flexibility of a design of a sinusoidal oscillator circuit also becomes can adjust oscillation frequency in a certain range, and increases it by changing the division state of this channel.
[0063] Moreover, according to invention of a claim 27, when using a channel as a signalling channel contrary to this, LC element with which the 2nd electrode was divided into plurality is formed, even if it is the case where a 2nd electrode side is divided, by changing this division state, oscillation frequency can be adjusted in a certain range, and the flexibility of a design of a sinusoidal oscillator circuit will increase it.
[0064] Moreover, according to invention of a claim 28, LC element which can change channel resistance is formed by changing each gate voltage of claims 11-27. thus, one inductor -- since the frequency characteristic of LC element will also be changed in connection with this adjustable extent when the channel resistance which is resistance of a conductor is controlled to adjustable, a sinusoidal armature-voltage control type oscillator circuit is easily realizable
[0065] Moreover, according to invention of claims 29 or 30, after forming direct or the 1st insulating layer on a semiconductor substrate, LC element is formed by forming so that the laminating of the 1st electrode, the 2nd insulating layer, and the 2nd electrode may be carried out. and the thing made for these [1st] and the 2nd electrode to counter mostly -- an inductor -- a distributed constant-capacitor is formed between these [which function as a conductor] two electrodes Although these LC elements differ in that the semiconductor substrate front face is used to LC element shown in the claims 4-28 mentioned above using the interior of a semiconductor substrate, there is no change in the ability to really form with other parts, such as an inverting amplifier, using this semiconductor substrate, and it is suitable for it at mass production method and a miniaturization of a sinusoidal oscillator circuit.
[0066] Moreover, according to invention of claims 31 or 32, LC element which constituted the insulating layer formed in inter-electrode [two] by the oxide and nitride by oxidization or the chemistry gaseous-phase method of an electrode is formed. Thus, a general semiconductor manufacturing technology is realized, and in case the process which forms an insulating layer, and the process which forms the electrode of a swirl or a meandering configuration really form the sinusoidal whole oscillator circuit with other parts, it becomes convenient.
[0067] Moreover, according to invention of a claim 33, LC element is formed by shortening either of two electrodes in claims 29-32, and making these electrodes counter partially.
[0068] thus, the inductor formed of two electrodes also in LC element formed using the front face of a semiconductor substrate -- it is possible to make a conductor counter partially and the

flexibility of a design of a sinusoidal oscillator circuit also becomes can adjust oscillation frequency in a certain range, and increases it by changing the rate which carries out partial opposite

[0069] Moreover, according to invention of a claim 34, LC element with which either of two electrodes in claims 29-33 was divided into plurality is formed, by changing this division state, oscillation frequency can be adjusted in a certain range, and the flexibility of a design of a sinusoidal oscillator circuit will increase it.

[0070] Moreover, according to invention of a claim 35, the point that the sinusoidal whole oscillator circuit is really formed on the semiconductor substrate is clear. That is, it is easy to realize the sinusoidal oscillator circuit which LC element of each claim is formed using a semiconductor substrate as mentioned above, and was really formed in one semiconductor substrate with the parts of the inverting amplifier constituted by an inverter logical circuit or a grounded-source circuit, and the grounded emitter circuit or others.

[0071]

[Example] Hereafter, the sinusoidal oscillator circuit of one example which applied this invention is explained concretely, referring to a drawing.

[0072] The [1st example] Drawing 1 is drawing showing the detailed composition of the sinusoidal oscillator circuit 1 of the 1st example which applied this invention.

[0073] As shown in this drawing, the sinusoidal oscillator circuit 1 of the 1st example is constituted including the inverter logical circuit 10 which functions as an inverting amplifier, the LC element 12 by which the inductor component and the capacitor component were formed in distributed constant on the semiconductor substrate, and the capacitor 16 which functions as a load.

[0074] The inverter logical circuit 10 operates as amplifier while it shifts reversal, i.e., a phase, 180 degrees and outputs the logic of an input signal. Although this inverter logical circuit 10 is realizable using arbitrary logic, such as TTL logic, in oscillating CMOS logic with a circuit design an input impedance is high and easy, and a sine wave with frequency high also in it, CMOS logic, such as 74HC series which is a high-speed type, is suitable.

[0075] A capacitor 16 functions as a load. When it can be made to serve a double purpose by the internal capacity of the inverter logical circuit 10, this capacitor 16 can also be omitted.

[0076] The LC element 12 is formed in [two inductor components and capacitor components] distributed constant on a semiconductor substrate, and feedback of a signal is performed through the inductor portion of one of these. Hereafter, the example of this LC element 12 is explained.

[0077] Drawing 2 is a plan at the time of constituting LC element by forming a spiral shape-like spiral electrode on a semiconductor substrate. Moreover, drawing 3 is the A-A line expanded sectional view shown in drawing 2 .

[0078] The LC element 12 of this example is n+ of the shape of spiral shape formed near the front face of the p-type-silicon substrate (p-Si substrate) 34 which is a semiconductor substrate. A field 32 and p+ of the shape of spiral shape further formed in the part The field 30 is included and they are these n+. A field 32 and p+ The field 30 forms the pn junction layer 36. Moreover, it compares with the p-Si substrate 34 mentioned above, and is n+. A field 32 and p+ High impurity concentration is set up more highly and each of a field 30 is this p-Si substrate 34 and n+. By impressing reverse bias voltage between fields 32, this p-Si substrate 34 functions as a good isolation field. In practice, they are the p-Si substrate 34 and n+ by making into this potential the p-Si substrate 34 and the I/O electrode 28 mentioned later. What is necessary is just to impress reverse bias voltage certainly between fields 32.

[0079] Moreover, the LC element 12 of this example is n+ mentioned above. It is the front-face side of a field 32, and is this n+. The 1st spiral shape-like spiral electrode 20 is formed in the position along the field 32. Similarly, it is p+. It is the front-face side of a field 30, and is p+. The 2nd spiral electrode 22 is formed in the position along the field 30. And two I/O electrodes 24 and 26 are connected to the ends of the 1st spiral electrode 20. The I/O electrode 28 is formed in the one side edge (for example, periphery side) of the 2nd spiral electrode 22. Thus, installation of the I/O electrodes 24 and 26 to the 1st and 2nd spiral electrodes 20 and 22 or the I/O electrode 28 is thin n+ as shown in drawing 2 . A field 32 or p+ It is carried out on the outside of an active region so that a field 30 may not be damaged.

[0080] each of the 1st in which the LC element 12 of this example which has such structure has the shape of spiral shape, and 2nd spiral electrodes 20 and 22 -- an inductor -- it will function as a conductor Moreover, it functions as the pn junction layer 36 electrically connected to each of the 1st and 2nd spiral electrodes 20 and 22 being used in the state of a reverse bias as a spiral shape-like capacitor. Therefore, the LC element 12 in which the inductor formed of the 1st and 2nd spiral electrodes 20 and 22 and the capacitor formed of the pn junction layer 36 exist in distributed constant is formed.

[0081] Drawing 4 is drawing showing the equal circuit of the LC element 12 of this example. As shown in this drawing (A), the 1st spiral electrode 20 functions as an inductor which has an inductance L1. And when connection shown in drawing 1 is made, the signal inputted from one I/O electrode 26 spreads through this 1st spiral electrode 20, and is outputted from the I/O electrode 24 of another side. Moreover, the 2nd spiral electrode 22 of another side functions as an inductor which has an inductance L2.

[0082] It is n+ when the voltage level of the 1st spiral electrode 20 is set up in the LC element 12 which has such an equal circuit more highly than the voltage level of the 2nd spiral electrode 22. A field 32 and p+ This pn junction layer 36 functions on the pn junction layer 36 which consists of a field 30 as a capacitor with which reverse bias voltage has capacitance C for this reason. Moreover, this capacitor is formed in distributed constant covering the overall length of the 1st spiral electrode 20 and the 2nd spiral electrode 22.

[0083] Drawing 4 (B) is the composition for impressing the reverse bias mentioned above. Specifically, the power supply 38 for bias for impressing predetermined reverse bias voltage among the I/O electrodes 24 and 28 is connected.

[0084] Moreover, as shown in this drawing (C), the capacitance C of the pn junction layer 36 formed in the shape of spiral shape can also be arbitrarily changed by connecting the power supply 44 for adjustable bias which can change the voltage level of a reverse bias arbitrarily instead of this power supply 38 for bias.

[0085] Since the width of face of the depletion layer generally produced in a pn junction side according to the size of the reverse bias voltage impressed to the pn junction layer 36 changes, the value of capacitance C is also changed in connection with this. Therefore, by changing the reverse bias voltage impressed to the pn junction layer 36 through two I/O electrodes 24 and 28, the capacitance C formed in distributed constant can be changed arbitrarily, and the frequency characteristic as the LC element 12 whole can be changed.

[0086] Moreover, drawing 5 is drawing showing the concrete composition for actually impressing a reverse bias in the sinusoidal oscillator circuit 1 shown in drawing 1 at the LC element 12, and the case where the power supply 44 for adjustable bias which can be changed is connected arbitrarily is shown in reverse bias voltage as an example.

[0087] In the sinusoidal oscillator circuit 1 of this example, as shown in drawing 1 , this LC

element 12 is used as a resonance circuit by [of the 1st of the LC element 12, and the 2nd spiral electrode 20 and 22] on the other hand connecting edges. However, since it is necessary to set it as potential which is different in these [1st] and the 2nd spiral electrode 20 and 22 in order to impress reverse bias voltage to the pn junction layer 36, some device is needed.

[0088] In drawing 5 (A), two I/O electrodes 24 and the capacitor 16 inserted among 28 (between the 1st and the 2nd spiral electrode 20, and 22) are the things for it. That is, by inserting a capacitor 16, while connecting the 1st and 2nd spiral electrodes 20 and 22 in alternating current, it has dissociated in direct current, and reservation of operation as a resonance circuit mentioned above and impression of reverse bias voltage to the pn junction layer 36 are enabled. Although it is desirable to have a sufficiently big capacity so that the resonance characteristic of the LC element 12 may not be affected, this capacitor 16 is not this limitation when determining the oscillation frequency of the sinusoidal oscillator-circuit 1 whole, taking the capacity of this capacitor 16 into consideration.

[0089] Moreover, when actually incorporating as a part of circuit, the adjustable bias power supply 44 shown in this drawing (A) can be constituted combining variable resistance 52 and the resistance 54 which has resistance big enough, as shown in this drawing (B). That is, predetermined reverse bias voltage is made by variable resistance 52 (however, actual reverse bias voltage with the potential by the side of the 2nd spiral electrode 22 set up by this variable resistance 52). By impressing this reverse bias voltage used as a difference with the potential of the 1st spiral electrode 20 by which the direct file was carried out to the outgoing end of the inverter logical circuit 10 to the I/O electrode 28 of the LC element 12 through the sufficiently strong resistance 54 The alternating current component of a signal is not affected, namely, the impression of reverse bias voltage which does not affect the resonance characteristic of the LC element 12 is attained.

[0090] Moreover, this drawing (C) is the case where replaced with the capacitor 16 by the side of the 2nd spiral electrode 22, and two capacitors 46 and 48 are formed in the both sides of the 1st spiral electrode 20. In order to take up and down the potential of the 1st spiral electrode 20 inserted in the feedback loop, it is necessary to separate the 1st whole spiral electrode 20 in direct current, and two capacitors 46 and 48 which were mentioned above for this reason are needed.

[0091] Thus, although it is necessary to form a capacitor and to separate these in direct current between the 1st and the 2nd spiral electrode 20, and 22 in order to impress reverse bias voltage to the pn junction layer 36 in the LC element 12, it is free whether which [of the 1st and 2nd spiral electrodes 20 and 22] near potential is taken up and down, and reverse bias voltage should just be relatively impressed to the pn junction layer 36.

[0092] In addition, although drawing 5 explained taking the case of the case where adjustable reverse bias voltage is impressed to the pn junction layer 36, you may make it impress the reverse bias voltage of fixation by the power supply 38 for bias of drawing 4 . Moreover, what is necessary is just to transpose the variable resistance 52 shown in drawing 5 (B) etc. to the partial pressure circuit which consists of two fixed resistance, in incorporating this power supply 38 for bias as a part of actual circuit.

[0093] Drawing 6 is drawing showing the manufacturing process of the LC element 12 of this example. The state for every manufacturing process of the B-B line cross section of drawing 2 is shown.

[0094] (1) Growth of an epitaxial layer : first, after removing the oxide film of p-Si substrate 34 (wafer) front face, it is n+ to the whole front face of the p-Si substrate 34. The type epitaxial layer 35 is grown up (this drawing (A)).

[0095] (2) Formation: of an isolation field, next n+ shown in drawing 2 A field 32 and p+ In order to make the field except a field 30 into an isolation field, diffusion or the ion implantation of p type impurity is performed.
[0096] Specifically, the front face of an epitaxial layer 35 is first oxidized thermally, and an oxide film 40 is formed. And after removing the oxide film 40 of the position which should form p field by the photolithography, p field is alternatively formed by adding p type impurity alternatively with thermal diffusion or an ion implantation. Thus, formed p field becomes a part of p-Si substrate 34, and forms an isolation field (this drawing (B)).
[0097] Thus, as a result of performing formation of an isolation field, it is spiral shape-like n+ by the left-behind epitaxial layer 35. A field 32 is formed.
[0098] (3) Formation: of a pn junction layer, next n+ formed in the shape of spiral shape By introducing p type impurity into a part of field 32 with thermal diffusion or an ion implantation, it is spiral shape-like p+. A field 30 is formed (this drawing (D)).
[0099] Specifically, it is n+ first. The front face of the p-Si substrate 34 including a field 32 is oxidized thermally, and an oxide film 42 is formed. And it is p+ by the photolithography. It is p+ by adding p type impurity alternatively with thermal diffusion or an ion implantation, after removing the oxide film 42 of the position which should form a field 30. A field 30 is formed alternatively.
[0100] This p+ A field 30 is n+ formed previously. It is p+ by adding p type impurity more than the amount of already introduced n type impurity, since it is necessary to form all over a field 32. A field 30 is formed.
[0101] Thus, n+ A field 32 and p+ The pn junction layer 36 of the shape of spiral shape which consists of a field 30 is formed.
[0102] (4) After forming an oxide film 43 in a front face by formation: of a spiral electrode, next thermal oxidation, it is n+ by the photolithography. A field 32 and p+ Spiral shape-like ****** is performed on each front face of a field 30, and the 1st and 2nd spiral electrodes 20 and 22 are formed by carrying out the vacuum evaporationo of the aluminum to the shape of this spiral shape after that **** this morning at a **** portion (this drawing (D)). Moreover, each of three I/O electrodes 24, 26, and 28 is formed by the vacuum evaporationo of aluminum after that.
[0103] The process which manufactures the LC element 12 of this example is fundamentally similar with the process which manufactures a usual bipolar transistor or usual diode, and the pn junction layer 36 differs from the configuration of an isolation field in the meantime etc. Therefore, it can respond by changing the configuration of a photo mask in the process which manufactures a general bipolar transistor, and while manufacture becomes easy, it is suitable also for the miniaturization.
[0104] In addition, it sets to the manufacturing process of the LC element 12 of this example mentioned above, and is n+ by epitaxial growth to the beginning. Although it explained taking the case of the case where isolation is performed after forming a field in the whole front face After forming an oxide film in the front face of the p-Si substrate 34, it is spiral shape-like n+ by the photolithography. ****** corresponding to a field 32 is performed. It is p+ directly by the method that it is the same after forming the n+ field 32 by introducing n type impurity into this portion with thermal diffusion or an ion implantation. You may form a field 30. Moreover, a general semiconductor manufacturing technology can be used about the method of forming a pn junction layer.
[0105] Thus, the LC element 12 of this example functions as a capacitor by using the pn junction layer 36 of the shape of spiral shape formed in inter-electrode [these] by the reverse bias while

each of the 1st and 2nd spiral electrodes 20 and 22 forms an inductor. And since the pn junction layer 36 is formed covering the overall length of the 1st and 2nd spiral electrodes 20 and 22, two inductors of the inductances L1 and L2 formed of the 1st and 2nd spiral electrodes 20 and 22 and the capacitor of the capacitance C formed of the pn junction layer 36 exist in distributed constant.
[0106] Drawing 7 is drawing showing the general property of the distributed constant type LC element 12 of having the structure shown in drawing 2 and drawing 3 .
[0107] In addition, the property shown in this drawing is LC element (for example, it measures using "3 terminal type noise filter" indicated by JP,2-26114,A.) formed by winding about after carrying out the laminating of the band-like conductor in which the I/O lead is attached near the ends, and the band-like conductor in which the lead for grounding is attached near the end on both sides of a dielectric sheet. This LC element is used as a 2 terminal element, and the result which measured the property between these two terminals by the vector impedance meter is shown by by [while it was prepared the lead for grounding and near this LC element] connecting an I/O lead electrically and dealing with it as a common lead. In addition, the characteristic curve shown by A and B of this drawing shows the result which changed and measured the various sizes and the number of winding of a band-like conductor, respectively.
[0108] If the size of an impedance is observed toward the RF side from the low frequency side about the LC element 12 shown by the characteristic curves A and B of this drawing, after becoming the maximum (a1 or b1) first, it will change so that it may become the minimum (a2 or b2). This maximum point shows the inclination as a parallel resonant circuit, and the dot shows the inclination as a series resonant circuit very much. Generally it is known that a phase will change a lot between dots very much with this maximum point, and the oscillation by resonance arises in the sinusoidal oscillator circuit 1 of this example on the specific frequency in the meantime decided by the relation with the element constant of a capacitor 16 or other parts used as a load.
[0109] When the LC element 12 which showed structure is actually formed in drawing 2 and drawing 3 Since the 1st and 2nd spiral electrodes 20 and 22 will be formed with a small path on the p-Si substrate 34, Compared with LC element formed by carrying out the laminating of the band-like conductor of two sheets on both sides of a dielectric sheet, and rolling it about The point that the inductor and the capacitor are formed in [any LC element] distributed constant has the same idea **, and a change does not have that the whole property shifts to a RF side in the inclination of the impedance characteristic itself.
[0110] The sinusoidal oscillator circuit 1 of this example has connected the LC element 12 and the inverter logical circuit 10 which have such a property in the shape of a ring. Therefore, when a loop gain is set or more to one by carrying out amplification degree of the inverter logical circuit 10 beyond a certain value, it oscillates on frequency from which the phase shift of the signal with which the phase of a signal shifts 180 degrees, and takes a round and returns in each of the LC element 12 and the inverter logical circuit 10 becomes 0 times or 360 degrees.
[0111] If a decreased part when taking a round of a feedback loop is suppliable with the amplification factor of the inverter logical circuit 10 which is an inverting amplifier while shifting a phase 180 degrees by the LC element 12 since a phase shifts 180 degrees by the inverter logical circuit 10 if it puts in another way, the oscillation of a certain frequency will be continued.
[0112] Thus, fundamentally, the sinusoidal oscillator circuit 1 of this example can only combine the parts of few kinds, such as one inverter logical circuit 10, LC element 12, and a capacitor 16, and can generate a sine wave simply. Since an inductor and a capacitor are formed in distributed

constant in one element unlike the conventional LC series resonant circuit, LC parallel resonant circuit, etc., in case especially the LC element 12 used as a 2 terminal element constitutes an oscillator circuit, the time and effort of it which prepares an inductor and a capacitor separately and is connected is lost.

[0113] For example, since a circuit design person can combine arbitrarily each part article manufactured according to a different material and a different process when the predetermined inductor and predetermined capacitor which have L and C are prepared individually, LC resonance circuit is constituted and it manufactures a sinusoidal oscillator circuit, while giving a circuit design person much flexibility, it will be forced the big burden about a design and manufacture.

[0114] On the other hand, since an inductor and a capacitor can manufacture simultaneously the LC element 12 shown in drawing 2 at the same process, while it can mitigate a circuit design person's burden, it has the advantage to which manufacture also becomes easy. Moreover, a property will also be stabilized, although the time and effort of wiring can be reduced of course, since the inductor and the capacitor are formed in one at the same process.

[0115] Therefore, if the sinusoidal oscillator circuit 1 can be constituted using the LC element 12 which has the advantage of such many, it can be said that it is also the advantage of the sinusoidal oscillator-circuit 1 whole as it is, a design and manufacture are easier for the sinusoidal oscillator circuit 1 of this example than the conventional sinusoidal oscillator circuit, and the advantage has the stable property.

[0116] Furthermore, the sinusoidal oscillator circuit 1 of this example has the big feature in the point that the LC element 12 which has an inductor component and a capacitor component is formed on the semiconductor substrate (p-Si substrate 34). And though natural, since the inverter logical circuit 10 and capacitor 16 which were shown in drawing 1 can also be formed on the same semiconductor substrate, the sinusoidal whole oscillator circuit 1 can really be formed on one semiconductor substrate, and mass production method and a miniaturization of the whole circuit are attained. Moreover, since one formation of the circuit to this semiconductor substrate top can be easily performed only by making a change of the configuration of a photo mask etc. using the present semiconductor manufacturing technology, the large cost cut accompanying mass production method or a miniaturization is also attained.

[0117] Moreover, the LC element 12 which showed structure to drawing 2 and drawing 3 can only change the value of the reverse bias voltage impressed to the pn junction layer 36, and can change the value of the capacitance C formed in distributed constant. Generally, if each element property of the inverter logical circuit 10 and a capacitor 16 is fixed and considered and the property shown in drawing 7 can change the capacitance C of the LC element 12 since it is determined based on the inductances L1 and L2 and capacitance C of the LC element 12, it will change the oscillation frequency of the sinusoidal oscillator circuit 1 itself according to the degree of the change.

[0118] Thus, let the sinusoidal oscillator circuit 1 of this example easily be an armature-voltage control type oscillator circuit by changing the reverse bias voltage impressed to the pn junction layer 36 of the LC element 12. And even if it is the case where it considers as such an armature-voltage control type oscillator circuit, it is not necessary to add the element for frequency change, and the component part of the sinusoidal oscillator circuit 1 can be pressed down to the minimum.

[0119] Drawing 8 is drawing showing the modification of the LC element 12 mentioned above. Although the 1st and 2nd spiral electrodes 20 and 22 are mostly formed in parallel, i.e., the almost same length, covering an overall length, the LC element 12 which showed structure to

drawing 2 and drawing 3 the 2nd spiral electrode 22 which showed LC element 12a shown in drawing 8 to drawing 2 and drawing 3 -- the predetermined number of turns (for example, about 1 turn) -- while shortening, the feature is that the pn junction layer 36 corresponding to this is also short a several minutes predetermined turn, and it carried out

[0120] As shown in drawing 8 , even if it is the case where the 2nd spiral electrode 22 and corresponding pn junction layer 36 are omitted partially Since the inductor formed of the 1st spiral electrode 20 which adjoins the 2nd spiral electrode 22 and this which became short, and the capacitor formed of the pn junction layer 36 which became short are formed in distributed constant, It will have the same property as the LC element 12 fundamentally shown in drawing 2 and drawing 3 .

[0121] Drawing 9 is drawing showing the equal circuit of LC element shown in drawing 8 . As shown in this drawing (A), only in the part whose number of turns of the 2nd spiral electrode 22 decreased, an inductance L3 and the capacitance C1 which becomes small and is formed in distributed constant corresponding to this become small.

[0122] Moreover, the composition for impressing fixation or adjustable reverse bias voltage to the pn junction layer 36 which became short is shown in this drawing (B) and (C). What is necessary is just to connect the power supply 38 for bias for impressing fixation or adjustable reverse bias voltage among the I/O electrodes 24 and 28, or the power supply 44 for adjustable bias like drawing 4 (B) and (C).

[0123] Thus, since the capacitance C1 formed in distributed constant of this pn junction layer 36 becomes small compared with the case of LC element shown in drawing 2 and drawing 3 when the pn junction layer 36 formed in inter-electrode [those] is formed short, while making the 1st of LC element 12a, and the 2nd spiral electrode 20 and 22 counter partially, the frequency characteristic also changes. If it puts in another way, while adjusting the length of these the 1st which counters partially, and 2nd spiral electrodes 20 and 22, by making into predetermined length the pn junction layer 36 formed between them, the desired frequency characteristic will be obtained and the oscillation frequency in the sinusoidal oscillator-circuit 1 grade of this example can be set up arbitrarily. As for this, the flexibility of a design of a sinusoidal oscillator circuit also becomes increases.

[0124] Drawing 10 is drawing showing other modifications of the LC element 12 mentioned above. While LC element 12b shown in this drawing divides the 2nd spiral electrode 22 side into plurality (for example, two division), the feature is in the point of having also divided into plurality the 1st and the 2nd spiral electrode 20, and the pn junction layer 36 formed among 22. That is, LC element 12b shown in this drawing is p+ which the 2nd spiral electrode 22 consists of two pieces 22-1 of a division electrode, and 22-2, and touches each [these] piece 22-1 of a division electrode, and 22-2. The field 30 is also divided. Divided every p+ Each and n+ of a field 30 2 sets of pn junction layers 36 are formed of the field 32. Furthermore, the I/O electrode 28 is formed in two pieces 22-1 of a division electrode, and the one way each edge (the outermost periphery side, most-inner-circumference side) of 22-2, respectively.

[0125] Drawing 11 is drawing showing the equal circuit of LC element shown in drawing 10 . As shown in this drawing (A), while the 1st whole spiral electrode 20 functions as an inductor which has an inductance L1, each piece 22-1 of a division electrode and each of 22-2 function as an inductor which has inductances L4 and L5. And the 1st spiral electrode 20, and each piece 22-1 of a division electrode and the pn junction layer 36 formed between each of 22-2 function as a capacitor which has capacitance C2 and C3, and, moreover, these capacitors are formed in distributed constant.

[0126] Moreover, the composition for impressing fixation or adjustable reverse bias voltage to the divided pn junction layer 36 is shown in drawing 11 (B) and (C). What is necessary is just to connect the power supply 38 for bias for impressing fixation or adjustable reverse bias voltage among the I/O electrodes 24 and 28, or the power supply 44 for adjustable bias like drawing 4 (B) and (C). Moreover, what is necessary is just to use the variable resistance 52 (partial pressure circuit which replaces with this and consists of two resistance when bias voltage is fixation) as shown in drawing 5 (B) or (C), and the resistance 54 which has sufficiently big resistance, in realizing such a power supply in an actual circuit.
[0127] Thus, when the 2nd spiral electrode 22 of LC element 12b and the pn junction layer 36 corresponding to this are divided, each piece 22-1 of a division electrode and the self-inductances L4 and L5 of 22-2 become small. Therefore, the influence of the property on the whole LC element by these self-inductances becomes small, and the property of the LC element 12 will be mostly determined by the inductance L1 which the 1st spiral electrode 20 has, and the capacitors C2 and C3 formed in distributed constant. For this reason, like LC element 12a shown in drawing 8 , by examining the division state of the 2nd spiral electrode 22, the configuration of the 1st spiral electrode 20 of determining a property mostly, etc., it can consider as LC element which has the desired frequency characteristic, and the flexibility of a design will increase.
[0128] The [2nd example] Drawing 12 is drawing showing the detailed composition of the sinusoidal oscillator circuit 2 of the 2nd example which applied this invention. The sinusoidal oscillator circuit 2 of this example has the feature in the point which is using the grounded-source circuit by MOS type (or assembling die) FET as an inverting amplifier to the sinusoidal oscillator circuit 1 of the 1st example mentioned above having used the inverter logical circuit 10 as an inverting amplifier.
[0129] That is, the sinusoidal oscillator circuit 2 shown in this drawing has the composition which transposed the inverter logical circuit 10 shown in drawing 1 to the resistance 58 connected to the drain side of MOS type FET56 by which the source side was grounded, and this FET56, and the grounded-source circuit which functions as an inverting amplifier by these FET56 and resistance 58 is constituted.
[0130] The principle of operation of the sinusoidal oscillator circuit 2 is the same as the sinusoidal oscillator circuit 1 mentioned above, the signal of specific frequency with which the phase shift of a signal which took a round by the LC element 12 and the grounded-source circuit becomes 0 times or 360 degrees is chosen, and an oscillation is performed on this frequency.
[0131] Moreover, about the LC element 12, it can constitute by forming the 1st and 2nd spiral electrodes 20 and 22 and pn junction layers 36 in the p-Si substrate 34 as shown in drawing 2 and drawing 3 , and there are not the sinusoidal oscillator circuit 1 which the grounded-source circuit where the connection method in a circuit also consists of MOS-FET56 and resistance 58 was used as an inverting amplifier, and also was shown in drawing 1 , and a changing place. In addition, it cannot be overemphasized that it can transpose to LC element 12a or 12b which showed the LC element 12 to drawing 8 and drawing 10 .
[0132] Thus, while using the grounded-source circuit which consists of FET56 and resistance 58 as an inverting amplifier, by connecting to this inverting amplifier in series the LC element 12 which an inductor and a capacitor are formed in distributed constant and has the predetermined resonance characteristic in the shape of a ring, the sinusoidal oscillator circuit 2 is constituted and a sine wave can be generated by easy composition.
[0133] In case it really forms on a semiconductor substrate since the sinusoidal whole oscillator circuit 3 of this example can be manufactured by the general semiconductor manufacturing

technology when a grounded-source circuit constitutes an inverting amplifier especially, it becomes still more convenient, and it is suitable for high-density-assembly-izing of a circuit, IC-izing, and LSI-ization.

[0134] Drawing 13 is drawing showing the modification of this example. Sinusoidal oscillator-circuit 3a shown in this drawing (A) has the feature in the point of having added the bias circuit to the sinusoidal oscillator circuit 2 shown in drawing 12 .

[0135] That is, in the sinusoidal oscillator circuit 2 shown in drawing 12 , since the return signal through the LC element 12 is inputted into the gate of direct FET56, it restricts, when FET56 is an MOS type by adjusting appropriately the element constant of the resistance 58 grade which constitutes a grounded-source circuit, and the operating point of FET56 is automatically set as the optimal value. On the other hand, in sinusoidal oscillator-circuit 3a shown in drawing 13 (A), the bias circuit which can set up arbitrary gate voltages is formed of the partial pressure circuit by resistance 60 and 62, and can adjust the optimal operating point of FET56 easily.

[0136] In addition, as for a capacitor 18, it is desirable to use what has the big capacity value of a grade which does not change the phase of the signal which functions as a dc-component separation circuit for removing a dc component, and is inputted from the signal which returns to the gate of FET56.

[0137] Moreover, sinusoidal oscillator-circuit 3b shown in drawing 12 (B) has the feature in the point which constituted the grounded-source circuit using FET64 of an assembling die.

[0138] While transposing MOS type FET56 to FET64 of an assembling die, the parallel circuit which is from resistance 82 and a capacitor 84 on the source side of FET64 is inserted, and a gate side is grounded through resistance 80.

[0139] The resistance 82 which constitutes this parallel circuit has low resistance comparatively. This is because there is a possibility that the voltage between source drains of FET64 may become small, and it may become impossible to secure the suitable operating point since the voltage drop according that resistance is not much big to resistance 82 becomes large. Moreover, a capacitor 84 is for grounding the source of FET64 in alternating current. Furthermore, resistance 80 has high resistance, and it stabilizes the bias by the side of this gate at the same time it makes it not ground the gate side of FET64 in alternating current. By such connection, reverse bias voltage is impressed relatively between the gate of FET64, the source, or a drain, and the grounded-source circuit by FET64 and resistance 58 operates as an inverting amplifier.

[0140] In addition, in the sinusoidal oscillator circuits 2, 3a, and 3b of the 2nd example mentioned above, when actually impressing fixation or adjustable reverse bias voltage to the LC elements 12 and 12a and the pn junction layer 36 in 12b, it cannot be overemphasized that it is necessary to separate the 1st and 2nd spiral electrodes 20 and 22 in direct current using capacitor 16 grade as shown in drawing 5 . Moreover, the same is said of the sinusoidal oscillator circuit of the 3rd example later mentioned about this point.

[0141] The [3rd example] Drawing 14 is drawing showing the detailed composition of the sinusoidal oscillator circuit 4 of the 3rd example which applied this invention. The sinusoidal oscillator circuit 4 of this example has the feature in the point which is using the grounded emitter circuit by the bipolar transistor as an inverting amplifier to having used the grounded-source circuit according [the sinusoidal oscillator circuits 2 and 3 of the 2nd example] the inverter logical circuit 10 to FET of an MOS type or an assembling die as an inverting amplifier as an inverting amplifier in the sinusoidal oscillator circuit 1 of the 1st example mentioned above.

[0142] That is, the sinusoidal oscillator circuit 4 shown in this drawing has the composition which transposed the inverter logical circuit 10 shown in drawing 1 to the grounded emitter

circuit which consists of a bipolar transistor 66 and resistance 68, and this grounded emitter circuit operates as an inverting amplifier.
[0143] In addition, predetermined bias is impressed to the base of a bipolar transistor 66 through resistance 70 from the collector, and, thereby, the suitable operating point is set up. Moreover, the capacitor 72 inserted in the feedback loop functions as a dc-component separation circuit for removing a dc component.
[0144] The principle of operation of the sinusoidal oscillator circuit 4 is the same as the sinusoidal oscillator-circuit 1 grade mentioned above, the signal of specific frequency with which the phase shift of a signal which took a round by the LC element 12 and the grounded emitter circuit becomes 0 times or 360 degrees is chosen, and an oscillation is performed on this frequency.
[0145] Moreover, like [element / LC / 12] the 1st example and the 2nd example, it can constitute by forming the 1st and 2nd spiral electrodes 20 and 22 and pn junction layers 36 in the p-Si substrate 34 as shown in drawing 2 and drawing 3 , and the sinusoidal oscillator-circuit 1 grade which the grounded emitter circuit which the connection method of a circuit also becomes from a bipolar transistor 66 and resistance 68 was used as an inverting amplifier, and also was shown in drawing 1 , and the changing place are not. In addition, it cannot be overemphasized that it can transpose to LC element 12a or 12b which showed the LC element 12 to drawing 8 and drawing 10 .
[0146] Thus, a sine wave can be generated by easy composition of connecting the inverting amplifier (grounded emitter circuit) and the LC element 12 which consist of a bipolar transistor 66 and resistance 68 in the shape of a ring.
[0147] Moreover, since the LC element 12 shown in drawing 2 and drawing 3 has a bipolar transistor and similar cross-section structure, it can form the sinusoidal whole oscillator circuit 4 containing these LC elements 12 and bipolar transistors 66 using the same semiconductor manufacturing technology, and really becomes still more convenient at the mass production method and the miniaturization by fabrication.
[0148] In addition, the partial pressure circuit by the resistance 60 and 62 as shown in drawing 13 (A) is added without using the resistance 70 for bias impression linked to the collector, and you may make it impress fixed bias voltage to the base of a bipolar transistor 66. Thus, by preparing the partial pressure circuit for bias impression independently, irrespective of the voltage level which appears in a collector, fixed bias voltage can always be impressed and the operating point by which the bipolar transistor 66 was stabilized can be secured now.
[0149] Other examples which applied [Other Example(s)], next this invention are explained. The various examples explained below realize the LC element 12 used in the 1st example mentioned above - the 3rd example according to other structures.
[0150] Drawing 15 is the plan showing the outline structure of LC element in other examples. Moreover, drawing 16 is the A-A line expanded sectional view shown in drawing 15 .
[0151] When LC element 12c of this example shown in these drawings forms the n field 130 near the front face of the p-Si substrate 134 which is a semiconductor substrate, the pn junction layer 136 which consists of an n field 130 and a p field 132 is formed.
[0152] Moreover, the 1st spiral shape-like spiral electrode 120 is formed in the front-face side of the n field 130 which LC element 12c of this example mentioned above. Similarly, it is the front-face side of the p field 132, i.e., the opposite side whose pn junction layer 136 was pinched to the 1st spiral electrode 120, and the 2nd spiral electrode 122 is formed in the 1st spiral electrode 120 and the position which counters mostly. And two I/O electrodes 24 and 26 are formed in the ends

of the 1st spiral electrode 120. The I/O electrode 28 is formed in the one side edge (for example, periphery side) of the 2nd spiral electrode 122.
[0153] each of the 1st which has the shape of spiral shape like the LC element 12 shown in drawing 2 and drawing 3 as for LC element 12c of this example which has such structure, and 2nd spiral electrodes 120,122 -- an inductor -- it will function as a conductor
[0154] Moreover, if the pn junction layer 136 formed between the 1st and 2nd spiral electrodes 120,122 is used in the state of a reverse bias, it will operate as a capacitor. In addition, as shown in drawing 22 , the pn junction layer 136 is considered to be one capacitor which has a big counterelectrode (each of the n field 130 and the p field 132 is equivalent to a counterelectrode). Generally each of the n field 130 and the p field 132 is compared with the 1st and 2nd spiral electrodes 120,122. However, since specific resistance is large, When an alternating current signal is passed between the 1st and 2nd spiral electrodes 120,122 An alternating current signal flows through the capacitor of the shape of spiral shape between the 1st which counters, and 2nd spiral electrodes 120,122, and an alternating current signal hardly flows to the capacitor formed between the circumference portions from which the 1st and 1st spiral electrodes 120,122 differ. Therefore, pn junction layers 136 other than each circumference portion of the 1st and 2nd spiral electrodes 120,122 can be considered that only the spiral shape-like portion which met the circumference portion of the 1st and 2nd spiral electrodes 120,122 operates as a capacitor substantially, without almost functioning as a capacitor.
[0155] Therefore, LC element 12c in which the inductor formed of the 1st and 2nd spiral electrodes 120,122 and the capacitor of the shape of spiral shape formed of the pn junction layer 136 exist in distributed constant is constituted.
[0156] The equal circuit of LC element 12c which has such structure can apply as it is what was shown in drawing 4 . Moreover, the same is said of the point that fixation or adjustable predetermined reverse bias voltage can be impressed, and a predetermined capacitor can be set up by this, by connecting the power supply 38 for bias or the power supply 44 for adjustable bias which impresses fixation or adjustable reverse bias voltage.
[0157] Drawing 17 is drawing showing the modification of the LC element 12 shown in drawing 15 , and corresponds to drawing 8 . namely, the 2nd spiral electrode 122 of LC element which showed 12d of LC elements shown in drawing 17 to drawing 15 -- the predetermined number of turns (for example, about 1 turn) -- the feature is in the shortened point and the spiral shape-like pn junction layer 136 which the 1st and the 2nd do spiral electrode 120,122, and functions as a distributed constant-capacitor also becomes short a several minutes predetermined turn with this change
[0158] Drawing 18 is drawing showing other modifications of LC element 12c shown in drawing 15 , and corresponds to drawing 10 . That is, while dividing the 2nd spiral electrode 122 into plurality (for example, two division), the feature is in the point of each [these] piece 122-1,122-2 of a division electrode of on the other hand having connected the I/O electrode 28 to each of an edge. What was shown in drawing 11 as an equal circuit is applicable as it is.
[0159] Thus, the pn junction layer 136 of the shape of spiral shape formed corresponding to this is also divided into plurality by dividing the 2nd spiral electrode 122 into plurality. Therefore, the self-inductance of each piece of a division electrode of the 2nd spiral electrode 122 becomes small, and the property of the whole LC element 12e will be mostly determined by each capacitance C2 and C3 which the 1st inductance L1 and divided pn junction layer 136 of the spiral electrode 120 have.
[0160] As shown in drawing 17 or drawing 18 , it becomes possible making the 1st and 2nd

spiral electrodes 120,122 counter partially or by dividing one 2nd spiral electrode 122 into plurality to consider as LC element for which the frequency characteristic differs from LC element 12c shown in drawing 15 . Therefore, by setting up arbitrarily length, and the 2nd place or number of partitions of the spiral electrode 122 to divide, LC element which has the desired frequency characteristic can be obtained, and the oscillation frequency of sinusoidal oscillator-circuit 1 grade which this showed to drawing 1 can be arbitrarily set up in a certain range.
[0161] In addition, although LC element which the 1st and 2nd spiral electrodes 120,122 mentioned above were made to counter mostly, and formed them explained the whole p-Si substrate 134 taking the case of the case where it considers as the pn junction layer 136 which consists of an n field 130 and a p field 132, as shown in drawing 19 , it is good also as the shape of spiral shape which met the 1st spiral electrode 120 in the n field 130 (or the p field 132 is sufficient). In this case, since a depletion layer will arise in the interface (pn junction side) of the n field 130 and the p field 132 which were formed in accordance with the shape of spiral shape and a spiral shape-like capacitor will be formed in it, a spiral shape-like capacitor can be formed more certainly than the structure shown in drawing 16.
[0162] Moreover, when actually using the p-Si substrate 134 as the pn junction layer 136 which consists of an n field 130 and a p field 132, it is necessary to make thickness of the p-Si substrate 134 thinner than the state of a wafer. Moreover, it is good also as structure as shown in drawing 20 in consideration of generally the direction of n type wafer being easy to come to hand.
[0163] That is, as shown in this drawing (A), after forming the p field 132 in the front face of the n-Si substrate 144 by epitaxial growth etc., it etches into the rear-face side of the n-Si substrate 144, and the 1st and 2nd spiral electrodes 120,122 are formed in the portion which performed this etching. Moreover, as shown in this drawing (B), it is p+ to order in the front-face side of the n-Si substrate 144. A field 146 and n+ After forming a field 148, the n-Si substrate 144 is etched, and the 1st and 2nd spiral electrodes 120,122 are formed in the portion which performed this etching. Moreover, it is spiral shape-like p+ so that a part of n-Si substrate 144 may be met mostly at the 1st spiral electrode 120, as shown in this drawing (C). After forming a field 146 Furthermore, it is spiral shape-like n+ on it. A field 148 is formed, it is the rear-face side of the n-Si substrate 144 after that, the portion corresponding to the 2nd spiral electrode 122 is etched, and the 1st and 2nd spiral electrodes 120,122 are formed in the portion which performed this etching.
[0164] Moreover, although LC element of each modification mentioned above illustrated the 1st spiral electrode 120 and the 2nd spiral electrode 122 so that it might counter completely, since the 1st and 2nd spiral electrodes 120,122 should just function as an electrode of the capacitor formed of the pn junction layer 136, a few may be shifted and it may arrange these spiral electrodes 120,122 so that it may counter mostly.
[0165] Drawing 21 is drawing showing other examples of LC element. 12f of LC elements shown in this drawing has the feature in the point of having changed the configuration of the 1st of the LC element 12 shown in drawing 2 , and the 2nd spiral electrode 20 and 22. Specifically, it has the 1st which replaces 12f of LC elements of this example with the 1st which has the shape of spiral shape in drawing 2 , and 2nd spiral electrodes 20 and 22, and has a meandering configuration, and 2nd electrodes 150,152, and the pn junction layer 154 which has a meandering configuration so that these two electrodes 150,152 may be met is formed.
[0166] Drawing 22 is drawing showing the principle of the inductor formed of the 1st which has a meandering configuration, and 2nd electrodes 150,152. As shown in this drawing, when Mukai's current is passed on the other hand to the electrode 150 which has the meandering

configuration crooked in the shape of irregularity, or 152, magnetic flux from which the sense becomes opposite in the adjoining concavo-convex portion occurs by turns, and the coil of 1/2 turn will be connected in series. Therefore, each of the 1st and 2nd electrodes 150,152 can function as an inductor which has a predetermined inductance, and can apply as it is what was shown in drawing 4 about an equal circuit.

[0167] Moreover, it becomes convenient in case the I/O electrodes 24, 26, and 28 are pulled out outside since the ends will be located in a periphery by the electrode 150,152 of a meandering configuration to either of the both ends of an electrode being located in a core, and another side being located in a periphery, when it considers as a spiral shape-like electrode.

[0168] Moreover, the 2nd electrode 152 side may be formed short, or you may make it divide it into plurality in 12f of LC elements which have such structure.

[0169] Drawing 23 shows 12g of LC elements which made the abbreviation half length by the side of the 2nd electrode 152 shown in drawing 21 , and corresponds to drawing 8 . Moreover, drawing 24 shows 12h of LC elements which divided this 2nd electrode 152 side into plurality (for example, two division), and corresponds to drawing 10 .

[0170] Moreover, drawing 25 -27 are drawing showing other examples of LC element. LC element 12i shown in drawing 25 forms the 1st which has a meandering configuration, and 2nd electrodes 160,162 so that it may counter mostly on both sides of the p-Si substrate 134, and it corresponds to drawing 15 . That is, LC element 12i of this example has the feature in the point which made the meandering configuration the configuration of the 1st and 2nd electrodes 160,162 to LC element 12c shown in drawing 15 making the spiral shape-like 1st and the 2nd spiral electrode 120,122 counter. Therefore, while each of the 1st which has a meandering configuration, and 2nd electrodes 160,162 functions as an inductor which has a predetermined inductance, the pn junction layer 136 (cross-section structure is the same as what was shown in drawing 16) of the meandering configuration inserted into these will function as a capacitor formed in distributed constant.

[0171] Moreover, by making into an abbreviation half the length of the 2nd electrode 162 shown in drawing 25 , LC element 12j shown in drawing 26 makes the 1st and 2nd electrodes 160,162 counter partially, and corresponds to drawing 17 . Furthermore, LC element 12k shown in drawing 27 connects the I/O electrode 28 to each edge, and corresponds to drawing 18 while it divides into two the 2nd electrode 162 shown in drawing 25 .

[0172] Thus, even if it is the case where the 1st of a meandering configuration and the 2nd electrode 160,162 are made to counter on both sides of the p-Si substrate 134 in which the pn junction layer 136 was formed, an inductor and a capacitor can form LC element formed in distributed constant, and can constitute the sinusoidal oscillator circuit shown in drawing 1 or drawing 12 using this LC element. And it is possible to combine on the p-Si substrate 134 in which the LC element 12 was formed, and to form inverter logical circuit 10 grade, and the mass production method and the miniaturization by fabrication can also really be realized easily.

[0173] Drawing 28 is drawing showing other examples of LC element. Moreover, drawing 29 is [the B-B line expanded sectional view of drawing 28 and drawing 31 of the A-A line expanded sectional view of drawing 28 and drawing 30] the C-C line expanded sectional views of drawing 28 .

[0174] 12m of LC elements of this example shown in these drawings has the feature in connecting between the sources 212 and the drains 214 which are the diffusion field formed in the position from which near the front face of the p-Si substrate 34 was far apart by the channel 222 formed of the impression of voltage to the spiral shape-like spiral electrode 210 which

functions as the gate.
[0175] In addition, since 12m (the same is said of LC element which has the MOS structure mentioned later) of LC elements of this example has MOS type cross-section structure, the name as it is is being used for them about the part corresponding to MOS type the source, a drain, etc. of FET which have fundamentally similar cross-section structure. Thus, since names, such as the source or a drain, are used for convenience, change of replacing a drain with the source is free.
[0176] The p-Si substrate 34 is reversed and the source 212 and the drain 214 which were mentioned above are n+. It is formed as a diffusion field of a layer. For example, As+ It is formed by pouring in ion by thermal diffusion or ion implantation, and raising high impurity concentration.
[0177] Moreover, the spiral electrode 210 which functions as the gate is formed on both sides of the insulating layer 226 formed in the front face of the p-Si substrate 34 so that one spiral shape-like edge may overlap some sources 212 and the other-end section may overlap a part of drain 214. The spiral electrode 210 is formed forming thin films, such as aluminum, and copper or silver, or by doping P so much with diffusion or an ion implantation.
[0178] Moreover, an insulating layer 226 is for insulating this p-Si substrate 34 and the spiral electrode 210 in the front face of the p-Si substrate 34. All the front faces (or portion corresponding to the spiral electrode 210 at least) of the p-Si substrate 34 are being worn by this insulating layer 226, and the spiral electrode 210 further mentioned above on the front face of this insulating layer 226 is formed. This insulating layer 226 is formed of SiO2 (P-glass) which added P.
[0179] Moreover, as shown in drawing 28 - drawing 31 , the I/O electrode 28 and the I/O electrodes 24 and 26 are connected to each of the spiral electrode 210 mentioned above, the source 212, and a drain 214. That is, as shown in drawing 28 , installation of the I/O electrode 28 to the spiral electrode 210 is performed on the outside of an active region so that a thin gate film (insulating layer 226) may not be damaged. Moreover, installation of the I/O electrode 24 to the source 212 and installation of the I/O electrode 26 to a drain 214 are performed by attaching metal membranes, such as aluminum, copper or gold, and silver, after exposing a part of source 212 and drain 214, as shown in drawing 31 or drawing 29 . Moreover, as shown in drawing 30 , the I/O electrode 26 connected to the spiral shape-like drain 214 mostly located in a part for a core is pulled out at the periphery side so that each circumference portion and insulating state of the spiral electrode 210 may be maintained.
[0180] When positive voltage (it is [as opposed to / a substrate, the source 212, and a drain 214 / correctly] positive voltage relatively) is impressed to the thing in which 12m of LC elements of this example which has the MOS structure mentioned above has the structure of an n channel enhancement type, then the spiral electrode 210, the n type channel 222 will be formed for the first time. and each of this channel 222 and the spiral electrode 210 mentioned above -- the object for spiral shape-like inductors -- while functioning as a conductor, a distributed constant-capacitor is formed between these channels 222 and the spiral electrode 210
[0181] Drawing 32 is the cross section showing the state where a channel 222 is formed, and the cross section perpendicularly taken to the direction of a whorl of the spiral electrode 210 is shown. In the state where the positive gate voltage is not impressed to the I/O electrode 28 connected to the spiral electrode 210 as opposed to the spiral electrode 210, as shown in this drawing (A), a channel 222 does not appear in the front face of the p-Si substrate 34. Therefore, it is in the state where the source 212 and the drain 214 which were shown in drawing 28 were insulated, in this state.

[0182] However, if a positive gate voltage is impressed to the spiral electrode 210, as shown in drawing 32 (B), the channel 222 which consists of an n field near the front face of the p-Si substrate 34 corresponding to the spiral electrode 210 will appear. Since this channel 222 is formed covering the overall length of the spiral electrode 210, among these, a distributed constant-capacitor will be formed of the charge accumulated at each of the spiral electrode 210 and a channel 222.
[0183] Drawing 33 is the cross-section structure of 12m of LC elements of this example, and the cross section which met in the direction of a whorl of the spiral electrode 210 is shown. As shown in this drawing, a channel 222 will be formed in parallel with the spiral electrode 210, and the source 212 and a drain 214 will be in switch-on by this channel 222. For example, in the case of an enhancement type, although this channel 222 will be formed for the first time where the voltage equivalent to a gate voltage is impressed to the spiral electrode 210, and the source 212 and a drain 214 will be in switch-on, since the width of face and the depth of a channel 222 change by changing the gate voltage impressed to the spiral electrode 210, the resistance of the channel 222 between the source 212 and a drain 214 can be changed.
[0184] Drawing 34 is drawing showing the equal circuit of 12m of LC elements of this example. A channel 222 is formed and the case where it functions as an inductor in which these each has inductances L1 and L2 is shown by when the equal circuit shown in this drawing (A) impresses predetermined bias voltage to the spiral electrode 210. Moreover, the capacitor of the shape of spiral shape which has Capacitor C by these spiral electrode 210 and the channel 222 is formed.
[0185] In addition, it is good also as DEPURESHON type structure of pouring the n type carrier into the position in which a channel 222 is formed beforehand so that it may mention later.
[0186] the inductor which has an inductance L1 since the channel 222 from which 12m of LC elements of this example which has such an equal circuit serves as a signal I/O way is formed in the shape of spiral shape -- it functions as a conductor the inductor in which similarly the spiral electrode 210 has an inductance L2 -- it functions as a conductor moreover, these two inductors -- since a conductor will be arranged on both sides of an insulating layer 226, the capacitor which has the predetermined capacitance C by these spiral electrode 210 and the channel 222 is formed in distributed constant
[0187] Therefore, like LC element shown in drawing 2 etc., an inductor and a capacitor are formed in distributed constant, and can replace and use 12m of this LC element for the LC element 12 in the sinusoidal oscillator circuit 1 shown in drawing 1 . Since 12m of especially this LC element has the MOS structure, its manufacturing process is simple and, moreover, it becomes convenient on the occasion of IC-izing or LSI-izing.
[0188] Moreover, drawing 34 (B) shows the composition in the case of impressing the adjustable gate voltage Vg to the spiral electrode 210. Since the depth of a channel 222 changes by changing the gate voltage Vg (gate voltage correctly impressed between the spiral electrode 210 and a substrate 224 in drawing 33) impressed to the I/O electrode 28 of the spiral electrode 210 prepared in the edge on the other hand, the mobility of a channel 222 can change and the resistance of a channel 222 can be transformed arbitrarily as a result.
[0189] Thereby, since the frequency characteristic in 12m of LC elements also changes, when the sinusoidal oscillator circuit shown in drawing 1 or drawing 12 using 12m of this LC element is constituted, the sinusoidal armature-voltage control type oscillator circuit from which the oscillation frequency changes according to the gate voltage Vg to impress can be realized easily.
[0190] In addition, although the case where 12m of LC elements mentioned above formed an n channel between the source 212 and a drain 214 was explained, since an electron is used as a

carrier in this case, mobility is large, and resistance of a channel 222 becomes small. On the other hand, you may make it form 12m of LC elements mentioned above by forming a p channel on an n-Si substrate. In this case, since a hole is used as a carrier, it will have a property which resistance of a channel 222 becomes comparatively large and is different as compared with the case of the n channel mentioned above.

[0191] Moreover, since 12m of LC elements mentioned above has the long spiral electrode 210 in the direction of a whorl and a channel 222 is formed certainly, it is necessary to set up lower than the potential of the spiral electrode 210 the potential by the side of a substrate 224.

[0192] Drawing 35 is drawing showing the manufacturing process of 12m of LC elements of this example, and the case of an enhancement type is shown as an example. In addition, this drawing takes a cross section in the direction of a whorl of the spiral electrode 210.

[0193] (1) Formation of an oxide film : form diacid-ized silicon by oxidizing thermally the front face of the p-Si substrate 34 first (this drawing (A)).

[0194] (2) Perform ****** of the portion corresponding to the source 212 and a drain 214 by performing photo etching to ******: of a source drain, next the oxide film of p-Si substrate 34 front face (this drawing (B)).

[0195] (3) Form the source 212 and a drain 214 by pouring in n type impurity from formation: of a source drain, next the portion which ******(ed) (this drawing (C)). For example, As+ is used as an n type impurity and this impurity is poured in by thermal diffusion. Moreover, in pouring in this n type impurity by ion implantation, ****** in (2) mentioned above becomes unnecessary.

[0196] (4) Form opening of a gate field by removing removal: of a gate field, next the oxide film of a portion forming the spiral electrode 210 in (this drawing (D)). In the case of 12m of LC elements of this example, since it is necessary to form the spiral electrode 210 in the shape of spiral shape, it is carried out so that formation of this gate field opening may also become spiral shape-like. Thus, the p-Si substrate 34 will expose only the portion corresponding to the spiral electrode 210.

[0197] (5) Perform formation of the new oxide film 226, i.e., an insulating layer, to formation: of a gate oxide film, next the p-Si substrate 34 which carried out in this way and was exposed partially (this drawing (E)).

[0198] (6) Form formation: of the gate and an electrode, next each of the I/O electrode 26 which is connected to the I/O electrode 24 and drain 214 which are connected to the source 212 while forming the spiral electrode 210 which functions as the gate by carrying out the vacuum evaporationo of the aluminum etc. (this drawing (F)).

[0199] Thus, the process which manufactures 12m of LC elements is fundamentally similar with the process which manufactures usual MOS-FET, and it can only be said that it is that the configurations of the spiral electrode 210 etc. differ. Therefore, it becomes convenient in case the sinusoidal oscillator circuit which really formed other parts of inverter logical circuit 10 grade with 12m of LC elements on one semiconductor substrate is formed.

[0200] Moreover, although the channel 222 formed corresponding to the spiral shape-like spiral electrode 210 was used for 12m of LC elements of this example shown in drawing 28 as a propagation path (a part of feedback loop) of a signal, you may make it replace the function of a channel 222 and the spiral electrode 210.

[0201] They connect the I/O electrode 28 to the source 212 (or drain 214) of a channel 222 formed in the edge on the other hand while this spiral electrode 210 is used for 12n of LC elements shown in drawing 36 as an I/O way of a signal by connecting the I/O electrodes 24 and 26 to the ends of the spiral electrode 210.

[0202] Generally, since it is high compared with the electrode of the spiral electrode 210, when the specific resistance of a channel 222 forms a feedback loop through the channel 222 of LC element in the sinusoidal oscillator-circuit 1 grade of drawing 1 , the magnitude of attenuation of the voltage level of a signal poses a problem. That is, since an oscillation will not be continued if the loop gain at the time of amplifying by the inverter logical circuit 10 which is an inverting amplifier is not one or more, it is necessary to give only the amplification factor with which a decreased part by the channel 222 is compensated to the inverter logical circuit 10. For this reason, when sinusoidal oscillator-circuit 1 grade is constituted using 12m of LC elements shown in drawing 28 , in order to examine enough the carrier density of the p-Si substrate 34 in which 12m of these LCs elements was formed etc., to make specific resistance of a channel 222 small or to form this channel 222 in sufficient depth, it is necessary to set up sufficiently greatly the reverse bias voltage (gate voltage) impressed between the spiral electrode 210 and a substrate 224.
[0203] On the other hand, in 12n of LC elements shown in drawing 36 , the case where the spiral electrode 210 is formed by the metallic material is common, since the series connection of the spiral electrode 210 comrades formed by the metallic material in this case is carried out and they form the feedback loop, specific resistance is small enough and such a problem does not arise.
[0204] Moreover, since it connects the I/O electrode 28 to either the source 212 or the drain 214 in using the spiral electrode 210 side as an I/O way of a signal, another side is omissible.
[0205] Moreover, although 12m of LC elements mentioned above etc. explained the element of the enhancement type in which a channel 222 is formed when the voltage level impressed to the spiral electrode 210 was relatively made high compared with a substrate 224, also let them be a DEPURESHON type. That is, n type field is formed by pouring a carrier into the field of the channel 222 shown in drawing 28 or drawing 36 beforehand. A channel 222 can be formed without making high relatively the voltage level impressed to the spiral electrode 210 by this. Or the relation of a voltage level, channel width, etc. which are impressed to the spiral electrode 210 is changeable. Moreover, you may pour the carrier to pour in only into some fields which met the spiral electrode 210.
[0206] Drawing 37 and drawing 38 are drawings showing the modification of 12m of LC elements shown in drawing 28 , and LC element 12r to which LC element 12p which the spiral electrode 210 and the channel 222 were made to counter partially divided the spiral electrode 210 side into drawing 38 at plurality (for example, two division) is shown in drawing 37 , respectively.
[0207] Functionally, LC element 12p shown in drawing 37 can respond to LC element 12a shown in drawing 8 , and can apply the equal circuit shown in drawing 9 . LC element 12r similarly shown in drawing 38 can respond to LC element 12b shown in drawing 10 , and can apply what was shown in drawing 11 as an equal circuit.
[0208] Thus, while each of the spiral electrode 210 and a channel 222 functions as an inductor even if it is the case where the spiral electrode 210 side is divided into plurality when the spiral electrode 210 and a channel 222 are made to counter partially or, there is no change in the point that a capacitor is formed in distributed constant among these, and it can apply to the sinusoidal oscillator-circuit 1 grade shown in drawing 1 . And in 12m of LC elements shown in drawing 28 , since LC element from which the frequency characteristic differs is formed, the oscillation frequency by sinusoidal oscillator-circuit 1 grade can be adjusted in the fixed range.
[0209] however, when LC element shown in drawing 38 is constituted as an element of an enhancement type In order not to form the feedback loop in the sinusoidal oscillator-circuit 1

grade which a channel 222 will also be divided in the division portion of the spiral electrode 210, and was shown in drawing 1 , It is near the front face of the p-Si substrate 34, and a carrier is beforehand poured into the position corresponding to this division portion, the diffusion field 213 is formed in it, and the divided channel 222 needs to enable it to always use it as one conductor through this diffusion field 213.

[0210] Drawing 39 - drawing 42 are drawings showing other examples of LC element, and the case where the gate electrode of LC element of an MOS structure mentioned above is formed in a meandering configuration is shown.

[0211] Specifically, drawing 39 corresponds to drawing 28 and 12s of LC elements which have the structure which transposed the spiral electrode 210 of the shape of spiral shape shown in drawing 28 to electrode 210a of a meandering configuration is shown. The sinusoidal oscillator circuit which used the channel 222 formed corresponding to this electrode 210a as a part of feedback loop is formed.

[0212] Similarly, drawing 40 corresponds to drawing 36 and the LC element 12 from which the electrode 210a side of a meandering configuration serves as an I/O way of a signal on the contrary [12s of LC elements shown in drawing 39] is shown.

[0213] 12t of LC elements to which drawing 41 corresponds to drawing 37 and electrode 210a of a meandering configuration and the channel 222 were partially made equivalent is shown.

[0214] the near front face of the p-Si substrate 34 corresponding to this division position while drawing 42 corresponds to drawing 38 and dividing the electrode 210a side of a meandering configuration into plurality -- the diffusion field 213 -- forming -- a channel 222 -- one inductor -- LC element 12u used as a conductor is shown

[0215] Thus, even if it is the case where electrode 210a and a channel 222 are formed in a meandering configuration, as drawing 22 was shown, each of electrode 210a and a channel 222 functions as an inductor, there is no change in the point that moreover a distributed constant-capacitor is formed among these, and the sinusoidal oscillator-circuit 1 grade shown in drawing 1 using LC element which has such structure can be constituted. And these LC elements can use and form an MOS manufacturing technology on the p-Si substrate 34, when really fabricating with other component parts (for example, inverter logical circuit 10) of the sinusoidal oscillator-circuit 1 grade shown in drawing 1 , they are suitable, and they can realize easily mass production method and a miniaturization of the sinusoidal whole oscillator circuit.

[0216] Drawing 43 is drawing showing other examples of LC element. Moreover, for drawing 44 , the A-A line expanded sectional view of drawing 43 and drawing 45 are [the C-C line expanded sectional view of drawing 43 and drawing 47 of the B-B line expanded sectional view of drawing 43 and drawing 46] the D-D line expanded sectional views of drawing 43 .

[0217] 12m of LC elements which showed LC element 12v shown in these drawings to drawing 28 -- the spiral electrode 210 -- an inductor -- the feature is in the point of having separated these functions, to having made the function of a conductor and a gate electrode serve a double purpose

[0218] Specifically, LC element 12v of this example is formed by connecting between the sources 212 and the drains 214 which were formed in the position from which near the front face of the p-Si substrate 34 which is a semiconductor substrate was far apart by the channel 222 formed of the impression of voltage to the 1st spiral shape-like spiral electrode 310.

[0219] The source 212 and the drain 214 which were mentioned above are n+ which reversed the p-Si substrate 34. It is formed as a field. For example, As+ It is formed by pouring in ion by thermal diffusion or ion implantation, and raising high impurity concentration.

[0220] The 1st spiral electrode 310 functions as the gate, and on both sides of the insulating layer 226 formed in the front-face side of the p-Si substrate 34, it is formed so that one spiral shape-like edge (periphery side) may overlap some sources 212 and the other-end section (center side) may overlap a part of drain 214. The 1st spiral electrode 310 is formed fabricating for example, an aluminum film or by doping P so much with diffusion or an ion implantation.
[0221] Moreover, it is almost parallel to the 1st spiral electrode 310 mentioned above, and the 2nd spiral electrode 312 is mostly formed in the shape of the said heart. A channel 222 is formed in the front face of the p-Si substrate 34 which counters the 1st spiral electrode 310 by impressing a predetermined gate voltage between this 2nd spiral electrode 312 and the 1st spiral electrode 310.
[0222] Moreover, as shown in drawing 43 - drawing 47 , the electrode 228 for control and the I/O electrodes 24, 26, and 28 are connected to each of the 1st spiral electrode 310 mentioned above, the source 212, a drain 214, and the 2nd spiral electrode 312. That is, as shown in drawing 43 , installation of the electrode 228 for control to the 1st spiral electrode 310 is performed on the outside of an active region so that a thin gate film may not be damaged. Moreover, installation of the I/O electrode 24 to the source 212 and installation of the I/O electrode 26 to a drain 214 are performed by attaching metal membranes, such as aluminum, after exposing a part of source 212 and drain 214, as shown in drawing 47 and drawing 45 . Furthermore, installation of the I/O electrode 28 to the 2nd spiral electrode 312 is performed in the position which was far apart from the active region so that a thin gate film might not be damaged like the electrode 228 for control.
[0223] When positive voltage (voltage higher than the 2nd spiral electrode 312) is impressed to the thing in which LC element 12v of this example which has the structure mentioned above has the structure of an n channel enhancement type, then the 1st spiral electrode 310, a channel 222 will be formed for the first time.
[0224] Drawing 44 (A) and (B) are drawings showing the state where a channel 222 is formed. In the state where the positive gate voltage is not impressed to the electrode 228 for control connected to the 1st spiral electrode 310 as opposed to the 1st spiral electrode 310, as shown in this drawing (A), a channel 222 does not appear in the front face of the p-Si substrate 34. Therefore, it is in the state where the source 212 and the drain 214 which were shown in drawing 43 were insulated, in this state.
[0225] However, if a positive gate voltage is relatively impressed to the 1st spiral electrode 310, the channel 222 which consists of an n field near the front face of the p-Si substrate 34 corresponding to the 1st spiral electrode 310 as shown in drawing 44 (B) will appear. Moreover, it is the interior of the p-Si substrate 34, and the depletion layer by which the electron hole was eliminated by the positive gate voltage impressed to the 1st spiral electrode 310 is formed in the outside of this channel 222. Therefore, on both sides of this depletion layer, the electron in a channel 222 and the electron hole in the p-Si substrate 34 counter, and are arranged, and a capacitor is formed of a channel 222 and the p-Si substrate 34 which exists in the outside on both sides of a depletion layer. And between the 2nd spiral electrode 312 and channels 222 by which this capacitor was connected to the p-Si substrate 34 since [of the 1st spiral electrode 310] it was mostly formed covering an overall length, a spiral shape-like capacitor will be formed in distributed constant.
[0226] Drawing 48 is drawing showing the equal circuit of LC element 12v of this example. The equal circuit shown in this drawing forms a channel 222 by impressing a predetermined gate voltage to the electrode 228 for control, and the case where this channel 222 is used as a part of

feedback loop of a sinusoidal oscillator circuit is shown.
[0227] In addition, LC element 12v mentioned above can set the I/O electrode 24 prepared in the source 212, and the I/O electrode 28 of the 2nd spiral electrode 312 prepared in the edge on the other hand as this potential. When applying this LC element 12v to the sinusoidal oscillator-circuit 1 grade shown in drawing 1 , the direct file of these two I/O electrodes 24 and 28 can be carried out without using the capacitor 16 grade shown in drawing 5 . Therefore, you may make it form two I/O electrodes 24 and 28 as one common electrode, as a part of structures of LC element 12v are transformed, for example, it is shown in drawing 49 . In this case, while the time and effort of the wiring in a back process is reduced, capacitor 16 grade can also aim at reduction of part mark by the bird clapper unnecessarily.
[0228] the inductor in which, as for LC element 12v of this example which has such structure, a channel 222 has an inductance L1 -- the inductor in which the 2nd spiral electrode 312 has an inductance L2 while functioning as a conductor -- it functions as a conductor moreover, these two inductors -- a conductor -- in between, the capacitor which has the predetermined capacitance C is formed in distributed constant Therefore, fundamentally, such LC element 12v has the same frequency characteristic as LC element shown in drawing 2 etc., and can use it for the sinusoidal oscillator-circuit 1 grade shown in drawing 1 . Moreover, since it has the MOS structure like 12m of LC elements shown in drawing 28 etc., simplification of the process by the MOS manufacturing technology is possible, it is possible to really form with other parts on the p-Si substrate 34 moreover, and mass production method and a miniaturization can be realized easily.
[0229] Drawing 50 and drawing 51 are drawings showing the modification of LC element 12v shown in drawing 43 . LC element 12w which this the 2nd spiral electrode 312 and channel 222 were made to counter partially is shown by by forming the 2nd spiral electrode 312 in drawing 50 short. Moreover, LC element 12x which divided the 2nd spiral electrode 312 into plurality (for example, two division) are shown in drawing 51 .
[0230] Moreover, drawing 52 - drawing 54 are drawings showing other modifications of LC element 12v shown in drawing 43 . Each LC element shown in these drawings has the feature in the point of having replaced the function of a channel 222 and the 2nd spiral electrode 312, and the 2nd spiral electrode 312 is being used for it as an I/O way (feedback loop) of a signal. Drawing 53 corresponds to drawing 50 and drawing 54 corresponds [drawing 52] to drawing 43 at drawing 51 , respectively.
[0231] For example, the 2nd spiral electrode 312 is formed by the metallic material, when it is used as a part of feedback loop in the sinusoidal oscillator-circuit 1 grade which showed this 2nd spiral electrode 312 to drawing 1 , there is little attenuation of the voltage level in this feedback loop, and there is an advantage which can set up low the amplification factor of the inverting amplifier of the inverter logical circuit 10 grade shown in drawing 1 . About this advantage, it is the same as that of 12n of LC elements shown in drawing 36 .
[0232] Drawing 55 is drawing showing the partial modification of LC element shown after drawing 43 , and the cross-section structure corresponding to drawing 44 is shown. Specifically, as shown in drawing 55 (A), the inversion layer 232 which consists of a p field of the shape of spiral shape which met the 1st and 2nd spiral electrodes 310,312 in part of the n-Si substrate 144 is formed. In LC element which has such cross-section structure, if a predetermined gate voltage is impressed to the electrode 228 for control of the 1st spiral electrode 310 prepared in the edge on the other hand, as shown in this drawing (B), a channel 222 will be formed near the front face of the n-Si substrate 144 corresponding to this 1st spiral electrode 310. And by impressing

reverse bias voltage between the n-Si substrate 144 and the inversion layer 232, the spiral shape-like inversion layer 232 is mutually separated electrically in each circumference portion, and a distributed constant--certainly capacitor comes to be formed between a channel 222 and the 2nd spiral electrode 312.

[0233] Drawing 56 - drawing 62 are drawings showing the modification of LC element shown after drawing 43 , and the case where opposite arrangement of the 1st and 2nd spiral electrodes 310,312 arranged mostly at parallel is mostly carried out on both sides of the p-Si substrate 34 is shown.

[0234] Drawing 56 corresponds to drawing 43 and LC element by which the channel 222 and the 2nd spiral electrode 312 which have the shape of spiral shape were formed in the almost same length is shown. Drawing 57 is the A-A line expanded sectional view of drawing 56 , and corresponds to the cross-section structure shown in drawing 44 . The spiral shape-like capacitor is formed in distributed constant of the channel 222 which LC element 12y of this example is formed so that the 1st and 2nd spiral electrodes 310,312 may counter mostly on both sides of the p-Si substrate 34, as the cross-section structure is shown in drawing 57 , and is formed corresponding to the 1st spiral electrode 310, and the 2nd spiral electrode 312 formed in the rear face of the p-Si substrate 34.

[0235] Drawing 58 corresponds to drawing 50 and LC element which the 1st and 2nd spiral electrodes 310,312 by which opposite arrangement was mostly carried out on both sides of the p-Si substrate 34 were made to counter partially is shown. Moreover, drawing 59 corresponds to drawing 51 and LC element which divided into plurality the 2nd spiral electrode 312 formed so that the 1st spiral electrode 310 might be countered mostly (for example, two division) is shown.

[0236] Moreover, although each LC element shown in drawing 56 , drawing 58 , and drawing 59 all forms in the I/O way of a signal a part of feedback loops, such as a sinusoidal oscillator circuit shown in drawing 1 using the channel 222 side, you may make it form this feedback loop, using the 2nd spiral electrode 312 side as a signal I/O way. The channel 222 in which drawing 62 is formed [case / where drawing 61 formed the length of a channel 222 short relatively, and makes the case where drawing 60 forms a channel 222 and the 2nd spiral electrode 312 in the almost same length counter partially] by dividing into plurality (for example, two division) in the 1st spiral electrode 310 corresponding to this is also divided into plurality.

[0237] Drawing 63 is drawing showing the partial modification in the above-mentioned LC element which carried out opposite arrangement of the 1st and 2nd spiral electrodes 310,312 mostly on both sides of the p-Si substrate 34. Specifically, the spiral shape-like inversion layer is formed in the intervals of each circumference portion of the 1st and 2nd spiral electrodes 310,312. That is, the inversion layer of the shape of spiral shape which becomes a part of p-Si substrate 34 from the n field 234 as shown in this drawing is formed. In LC element which has such structure, if its attention is paid to p-Si substrate 34 comrades connected to the 2nd spiral electrode 312 from which a circumference portion differs, since the n field 234 is formed in between, it dissociates electrically, and isolation of each circumference portion can be performed certainly.

[0238] Moreover, when manufacturing LC element mentioned above using the p-Si substrate 34 which is actually in the state of a wafer, the specific resistance of the p-Si substrate 34 needs to make thickness of the p-Si substrate 34 thinner than the state of a wafer in consideration of a high thing etc. compared with a common metal. Moreover, it is good also as structure as shown in drawing 64 in consideration of generally the direction of n type wafer being easy to come to hand as mentioned above.

[0239] That is, as shown in this drawing (A), the shape of spiral shape is etched into one field of the n-Si substrate 144, and the 1st or 2nd spiral electrode 310,312 is formed in the portion which performed this etching. Moreover, it is p+ so that the 1st and 2nd spiral electrodes 310,312 may resemble a part of n-Si substrate 144, respectively and it may be met mostly, as shown in this drawing (B). A field 236 is formed, it is the rear-face side of the n-Si substrate 144 after that, the portion corresponding to the 2nd spiral electrode 312 is etched, and, finally the 1st and 2nd spiral electrodes 310,312 are formed.
[0240] Thus, by shortening the interval between the 1st formed so that it might counter mostly, and 2nd spiral electrodes 310,312, a distributed constant-capacitor will be formed only between the channel 222 and the 2nd spiral electrode 312 which counter mostly. And since pnp structure is formed in contact with the circumference portion from which the 2nd spiral electrode 312 differs when an inversion layer is formed in the portion pinched by the 1st and 2nd spiral electrodes 310,312, as shown in this drawing (B), good isolation is performed in each circumference portion.
[0241] Moreover, each LC element explained in each drawing after drawing 43 mentioned above may form these in a meandering configuration, although the 1st and 2nd spiral electrodes 310,312 are formed in the shape of spiral shape. each of the channel 222 formed corresponding to 1st electrode 310a which drawing 65 - drawing 76 transpose the 1st and 2nd spiral electrodes 310,312 mentioned above to the 1st which has a meandering configuration, and 2nd electrodes 310a and 312a, and has a meandering configuration, and 2nd electrode 312a -- an inductor -- it functions as a conductor and there is no change in the point that a distributed constant-capacitor is formed among these
[0242] Specifically, drawing 65 has the 1st and 2nd electrodes 310a and 312a which are the almost same length and were formed in parallel, and LC element which uses a channel 222 side as an I/O way of a signal is shown. LC element to which 2nd electrode 312a was short formed in drawing 66 , and the 1st and 2nd electrodes 310a and 312a countered it partially is shown. LC element with which 2nd electrode 312a was divided into plurality (for example, two division) is shown in drawing 67 . Moreover, LC element which changed the channel 222 of LC element and the function of 2nd electrode 312a which were shown in them to each of drawing 68 - drawing 70 is shown. furthermore, drawing 71 - drawing 76 -- respectively -- being alike -- LC element which made 2nd electrode 312a counter 1st electrode 310a mostly on both sides of the p-Si substrate 34 shows -- having -- **** -- drawing 71 -- drawing 65 -- drawing 72 -- drawing 66 -- drawing 73 -- drawing 67 -- in drawing 74 , drawing 75 corresponds to drawing 69 and drawing 76 corresponds to drawing 68 at drawing 70 , respectively
[0243] While each LC element mentioned above forms a distributed constant-capacitor, using the interior of a semiconductor substrate partially, the feature is that it enabled manufacture of the whole LC element using the semiconductor manufacturing technology. on the other hand, the ** which does not use the interior although the point of using a semiconductor substrate is the same -- the inductor of plurality [front face / the] -- LC element can also be constituted by forming a conductor in piles
[0244] Drawing 77 is the schematic diagram showing other modifications of LC element.
[0245] LC element 12z shown in this drawing is constituted including the 1st and 2nd spiral electrodes 322,324 formed in the semiconductor substrate 320 and this front face of a high grade almost in piles. It corresponds to the 1st spiral electrode 20 shown in drawing 2 , and the 1st spiral electrode 322 is equivalent to the 2nd spiral electrode 22 which shows the 2nd spiral electrode 324 to drawing 2 . Moreover, between these [1st] and the 2nd spiral electrode 322,324,

the insulator layer which is not illustrated except for the periphery side edge section is formed.
[0246] therefore, the thing for which the terminal equivalent to the I/O electrodes 24 and 26 shown in drawing 2 is prepared in the ends of the 1st spiral electrode 322 -- this 1st spiral electrode 322 -- one inductor -- it can be made to function as a conductor Moreover, since it is formed in this 1st spiral electrode 322 almost in piles while the direct file of the 2nd spiral electrode 324 is carried out to the periphery side edge section of the 1st spiral electrode 322 in the periphery side edge section, a distributed constant-capacitor is formed between these two spiral electrodes 322,324, and the relation of these inductor components and capacitor components becomes completely the same as the LC element 12 shown in drawing 2 etc.
[0247] For this reason, the same sinusoidal oscillator circuit as the sinusoidal oscillator-circuit 1 grade shown in drawing 1 can be obtained by forming a feedback loop through the 1st spiral electrode 322 of LC element 12z shown in drawing 77 .
[0248] Since especially LC element 12z shown in drawing 77 is formed using the semiconductor substrate 320, it can also form other one part (for example, inverter logical circuit 10 grade) in all shown in drawing 1 on this semiconductor substrate 320, and mass production method and a miniaturization can realize it easily.
[0249] Drawing 78 is drawing showing an example of the manufacturing process of LC element which showed outline structure to drawing 77 . This drawing shows the cross-section structure of LC element 12z in order of each process.
[0250] (1) Prepare the semiconductor substrate 320 of a high grade (this drawing (A)). Purity can also use this semiconductor substrate 320 for a low case as an insulating substrate by forming an oxide film etc. in the front face.
[0251] (2) Carry out the vacuum evaporationo of formation, for example, the aluminum film 324a, for a metal membrane on this semiconductor substrate 320 (this drawing (B)). In addition, you may make it form a metal membrane by other materials, such as gold and copper.
[0252] (3) Form the pattern of spiral shape-like photoresist 330a on aluminum film 324a (this drawing (C)). Formation of this pattern can be performed for example, by the photo-etching method.
[0253] (4) Form the 2nd spiral electrode 324 by using this photoresist 330a as a mask, and removing aluminum film 324a partially (this drawing (D)). Then, photoresist 324a is washed out.
[0254] (5) Carry out the mask of the edge (periphery side edge section) of the 2nd spiral electrode 324 formed by doing in this way by photoresist 330b (this drawing (E)).
[0255] (6) Perform anodic oxidation and form the insulating oxide film 326 in the front face of the remaining portion (portion by which a mask is not carried out) of the 2nd spiral electrode 324 (this drawing (F)). Then, photoresist 330b is washed out.
[0256] (7) Carry out the vacuum evaporationo of formation, for example, the aluminum film 322a, for a metal membrane to all front faces again (this drawing (G)). At this time, direct aluminum film 322a is formed on the periphery side edge section (portion in which the mask was carried out by photoresist 330b) of the 2nd spiral electrode 324, and electric connection is made in this portion.
[0257] (8) Form the pattern of spiral shape-like photoresist 330c on aluminum film 322a (this drawing (H)). Formation of this pattern can be performed by the photo-etching method like the case of photoresist 330a mentioned above, for example.
[0258] (9) Form the 1st spiral electrode 322 by using this photoresist 330c as a mask, and removing aluminum film 332a partially. Then, photoresist 330c is washed out.
[0259] Drawing 79 is drawing showing the flat-surface configuration of LC element 12z formed

on the semiconductor substrate 320 through such a process. As shown in this drawing, it corresponds to each of two I/O electrodes 24 (this I/O electrode 24 serves also as the function of the I/O electrode 28), and 26 with which the 1st spiral electrode 322 is formed in the front face, and each of the both ends of this 1st spiral electrode 322 indicated LC element 12z of this example to be to drawing 2 .

[0260] Drawing 80 is drawing showing other examples of the manufacturing process of LC element which showed outline structure to drawing 77 . According to the manufacturing process shown in drawing 78 , it differs according to the manufacturing process which showed between two spiral electrodes 322,324 to drawing 80 although LC element which insulates by the insulating oxide film 326 formed of anodic oxidation was manufactured in that LC element which transposed this insulating oxide film 326 to the silicon oxide or nitride formed by the chemistry gaseous-phase method (CVD) is manufactured. Hereafter, the manufacturing process is explained.

[0261] (1) Prepare the semiconductor substrate 320 of a high grade (this drawing (A)). And the 1st silicon oxide 340 is formed by the chemistry gaseous-phase method on this semiconductor substrate 320 (this drawing (B)). However, since specific resistance is high when the semiconductor substrate 320 of a high grade is used, the 1st silicon oxide 340 is also omissible.

[0262] (2) Carry out the vacuum evaporationo of the metal membrane 324b, such as the metal which can bear the process of the following chemistry gaseous-phase method, for example, gold, a tungsten, molybdenum, a tantalum, and niobium, on the 1st silicon oxide 340 (this drawing (C)).

[0263] (3) Form the pattern of spiral shape-like photoresist 330a on metal membrane 324b (this drawing (D)). Formation of this pattern can be performed for example, by the photo-etching method.

[0264] (4) Form the 2nd spiral electrode 324 by using this photoresist 330a as a mask, and removing metal membrane 324b partially (this drawing (E)). Then, photoresist 330a is washed out.

[0265] (5) Form the 2nd silicon oxide 342 by the chemistry gaseous-phase method on the 2nd spiral electrode 324 and the 1st exposed silicon oxide 340 (this drawing (F)). Then, etching etc. removes the 2nd silicon oxide 342 on the periphery side edge section of the 2nd spiral electrode 324.

[0266] (6) Carry out the vacuum evaporationo of the metal membrane 322b on this 2nd silicon oxide 342 (this drawing (G)). Since there is no process of a chemistry gaseous-phase method in a back process, although this metal membrane 322b can be used as an aluminum film, you may form by other metallic materials, such as gold and copper. At this time, direct metal membrane 322b is formed on it, and, only as for the periphery side edge section of the 2nd spiral electrode 324, electric connection is made in this portion.

[0267] (7) Form the pattern of spiral shape-like photoresist 330c on metal membrane 322b (this drawing (H)). Formation of this pattern can be performed by the photo-etching method like the case of photoresist 330a mentioned above, for example.

[0268] (8) Use this photoresist 330c as a mask, and form the 1st spiral electrode 322 (this drawing (I)). Then, photoresist 330c is washed out.

[0269] Also by using such a process, LC element 12z which showed the planar structure to drawing 79 can be manufactured. Thus, since LC element 12z of this example mentioned above is formed in the front face of the semiconductor substrate 320, it can form the parts (for example, inverter logical circuit 10) of others of sinusoidal oscillator-circuit 1 grade shown in drawing 1

using this semiconductor substrate 320, and can really realize easily the miniaturization of the mass production method by formation, and the whole circuit.
[0270] In addition, although LC element 12z which showed outline structure to drawing 77 formed the 1st and 2nd spiral electrodes 322,324 in the shape of [of the almost same length] spiral shape, you may make it make these two electrodes counter partially, and may make it divide the 2nd spiral electrode 324 side into plurality. Moreover, you may make it form two electrodes which have a meandering configuration as shown not only in the shape of spiral shape but in drawing 21 etc. almost in piles. Furthermore, as the center of each circumference portion of other electrodes comes in the intervals of each circumference portion of one electrode, you may make it not only making the 1st and 2nd spiral electrodes 322,324 counter mostly but pile up the 1st and 2nd spiral electrodes 322,324 partially.
[0271] Moreover, although the one way each edge of the 1st and 2nd spiral electrodes 322,324 was connected inside LC element 12z in order to set the 1st and 2nd spiral electrodes 322,324 as this potential, each one side edge is separately pulled out to the element exterior, and you may make it connect LC element 12z which showed outline structure to drawing 77 .
[0272] In addition, this invention is not limited to the above-mentioned example, and deformation implementation various by within the limits of the summary of this invention is possible for it.
[0273] for example, each LC element mentioned above -- an inductor, although the electrode and channel which function as conductors were formed in the shape of spiral shape, and the meandering configuration In the shape of [this] spiral shape, the thing of about 1 round or less than 1 round is also contained, the thing of the nonlinear configuration a wave and whose number of irregularity are 1 or about 2 is also contained in the meandering configuration, and the number of the circumference can choose the electrode configuration of LC element to be used suitably according to the size of an inductance etc.
[0274] Moreover, although mainly formed using the p-Si substrate, you may make it form similarly LC element of each example mentioned above using a n-type-semiconductor substrate (n-Si substrate). Moreover, you may make it a semiconductor substrate use the amorphous silicon which are material other than silicon, such as germanium, or amorphous materials.
[0275]
[Effect of the Invention] As mentioned above, according to invention of a claim 1, it is constituted by connecting an inverting amplifier and LC element in the shape of a ring, and a sine wave can be simply generated only by combining fewer parts. Moreover, since two or more LC elements mentioned above are formed on the semiconductor substrate, it is possible to form all the parts containing an inverting amplifier on a semiconductor substrate, and the mass production method and the miniaturization of a circuit using the semiconductor manufacturing technology of them are attained. Since especially these each part article can also be formed on one semiconductor substrate and the whole circuit will really be formed on a semiconductor substrate in this case, mass production method and the miniaturization of a circuit become still easier.
[0276] Moreover, according to invention of claims 2 or 3, the grounded-source circuit or grounded emitter circuit using the inverter logical circuit or the transistor constitutes the inverting amplifier mentioned above, and a sine wave can be simply generated only by such structure combining a simple inverting amplifier and LC element. Generally, especially the inverter logical circuit, grounded-source circuit, or grounded emitter circuit mentioned above becomes still more convenient, when it is formed on a semiconductor substrate and really forms

with other parts.
[0277] Moreover, two electrodes which according to invention of a claim 4 were on the semiconductor substrate, adjoined in the shape of the said heart, and have been arranged, Since LC element mentioned above by the pn junction layer of the shape of spiral shape formed along with these two electrodes is formed and this LC element is especially formed in a semiconductor substrate using a semiconductor manufacturing technology, It becomes convenient in case it really forms on a semiconductor substrate with the other parts, such as an inverting amplifier.
[0278] Moreover, according to invention of a claim 5, since LC element is formed and this LC element is also formed in a semiconductor substrate using a semiconductor manufacturing technology by carrying out opposite arrangement of the two electrodes of each other prepared in the shape of the said heart on the semiconductor substrate in the claim 4 on both sides of a semiconductor substrate, it becomes convenient in case it really forms with the other parts, such as an inverting amplifier.
[0279] Moreover, according to invention of claims 6 and 7, by transposing the electrode in claims 4 and 5 to a meandering configuration from the shape of spiral shape, LC element is formed, there is an advantage which can pull out this wiring, without intersecting a part of electrode when [of an electrode] wiring an edge or ends on the other hand, and simplification of the manufacturing process of the sinusoidal whole oscillator circuit is attained.
[0280] moreover, the thing for which either of two electrodes is formed short according to invention of a claim 8 -- an inductor -- LC element which the conductor countered partially is formed, and since oscillation frequency can be adjusted in a certain range by changing the rate of the electrode which carries out partial opposite etc., the flexibility of a design of a sinusoidal oscillator circuit also becomes increases
[0281] moreover, the inductor which was divided by dividing the pn junction layer corresponding to plurality for either of two electrodes into plurality with division or division of this electrode according to invention of a claim 9 -- LC element with little influence by the conductor is formed, and since oscillation frequency can be adjusted in a certain range by changing the division state of an electrode, the flexibility of a design of a sinusoidal oscillator circuit also becomes increases
[0282] Moreover, according to invention of a claim 10, by changing the reverse bias voltage impressed to a pn junction layer, LC element which can change the capacity value of the capacitor formed in distributed constant is formed, and the sinusoidal armature-voltage control type oscillator circuit which can control oscillation frequency in a certain range can be easily realized by using such a LC element.
[0283] Moreover, according to invention of claims 11-14, LC element of the MOS structure in which the gate has the shape of spiral shape and a meandering configuration is formed, and each of these LC elements can be manufactured only by changing the configuration of a mask etc. using the process which manufactures the usual MOS transistor, and in case it really forms on a semiconductor substrate with the other parts, such as an inverting amplifier, they become convenient. Since the sinusoidal whole oscillator circuit can be made into an MOS structure when an inverting amplifier also has an MOS structure especially (for example, when inverter logical circuits, such as an MOS transistor and CMOS, constitute), simplification of a manufacturing process and high-density-assembly-ization of each part article are attained, and when incorporating as a part of IC or LSI, it becomes convenient especially.
[0284] Moreover, according to invention of claims 15-22, mostly, LC element of an MOS structure is formed in the gate electrode of each LC element of claims 11-14 mentioned above

parallel or by preparing the 2nd electrode so that it may counter mostly, and the gate electrode is used independently for reverse bias impression. Therefore, the voltage impression to a gate electrode and transmission of the signal through a channel or the 2nd electrode are separable, and when setting up different bias voltage for two or more LC elements of every, it becomes convenient especially.

[0285] Moreover, according to invention of claims 23 or 24, by making the gate electrode in claims 11-22, a channel, or two electrodes counter partially, LC element is formed, oscillation frequency can be adjusted in a certain range by changing this rate that carries out partial opposite, and the flexibility of a design of a sinusoidal oscillator circuit also becomes increases.

[0286] Moreover, DEPURESHON type LC element which pours in the carrier beforehand is formed in the position in which the channel mentioned above is formed according to invention of a claim 25, since channel resistance and the current between source drains are changeable by adjusting the amount of the carrier poured in beforehand, the property of LC element can be adjusted in a certain range, and the flexibility of a design of a sinusoidal oscillator circuit also becomes increases.

[0287] Moreover, according to invention of claims 26 or 27, LC element with which the channel formed corresponding to a gate electrode or the 2nd electrode was divided into plurality is formed, oscillation frequency can be adjusted in a certain range by changing this division state, and the flexibility of a design of a sinusoidal oscillator circuit also becomes increases.

[0288] Moreover, since according to invention of a claim 28 LC element which can change channel resistance is formed and the frequency characteristic of LC element will also be changed according to the grade of change of this channel resistance by changing each gate voltage of claims 11-27, a sinusoidal armature-voltage control type oscillator circuit is easily realizable.

[0289] Moreover, according to invention of claims 29 or 30, after forming direct or the 1st insulating layer on a semiconductor substrate, by forming so that the laminating of the 1st electrode, the 2nd insulating layer, and the 2nd electrode may be carried out, there is no change in LC element being formed and really being able to form with other parts, such as this LC element, inverting amplifier, etc., using a semiconductor substrate, and it is suitable for it at mass production method and a miniaturization of a sinusoidal oscillator circuit.

[0290] Moreover, a general semiconductor manufacturing technology is realized, and in case the process which LC element which constituted the insulating layer formed in inter-electrode [two] by the oxide and nitride by oxidization or the chemistry gaseous-phase method of an electrode according to invention of claims 31 or 32 is formed, and does in this way and forms an insulating layer, and the process which forms the electrode of a whorl or a meandering configuration really form the sinusoidal whole oscillator circuit with other parts, it becomes convenient.

[0291] Moreover, according to invention of a claim 33, by shortening either of two electrodes in claims 29-32, and making these electrodes counter partially, LC element is formed, oscillation frequency can be adjusted in a certain range by changing this rate that carries out partial opposite, and the flexibility of a design of a sinusoidal oscillator circuit also becomes increases.

[0292] Moreover, according to invention of a claim 34, LC element with which either of two electrodes in claims 29-33 was divided into plurality is formed, by changing this division state, oscillation frequency can be adjusted in a certain range, and the flexibility of a design of a sinusoidal oscillator circuit will increase it.

[0293] Moreover, according to invention of a claim 35, it is easy to realize the sinusoidal oscillator circuit which really formed the inverting amplifier which are semiconductor parts with

LC element which clarified the point which can really form the sinusoidal whole oscillator circuit on a semiconductor substrate, and was formed using the semiconductor substrate.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the composition of the sinusoidal oscillator circuit of the 1st example which applied this invention.
[Drawing 2] It is drawing showing an example of LC element.
[Drawing 3] It is the A-A line expanded sectional view of drawing 2 .
[Drawing 4] It is drawing showing the equal circuit of LC element shown in drawing 2 .
[Drawing 5] It is drawing showing the concrete composition for impressing bias voltage to LC element in a sinusoidal oscillator circuit.
[Drawing 6] It is drawing showing the manufacturing process of LC element shown in drawing 2 .
[Drawing 7] It is drawing showing the property of distributed constant type LC element.
[Drawing 8] It is drawing showing the modification of LC element shown in drawing 2 .
[Drawing 9] It is drawing showing the equal circuit of LC element shown in drawing 8 .
[Drawing 10] It is drawing showing other modifications of LC element.
[Drawing 11] It is drawing showing the equal circuit of LC element shown in drawing 10 .
[Drawing 12] It is drawing showing the composition of the sinusoidal oscillator circuit of the 2nd example which applied this invention.
[Drawing 13] It is drawing showing the modification of the 2nd example.
[Drawing 14] It is drawing showing the composition of the sinusoidal oscillator circuit of the 3rd example which applied this invention.
[Drawing 15] It is drawing showing the modification of LC element.
[Drawing 16] It is the A-A line expanded sectional view of drawing 15 .
[Drawing 17] It is drawing showing other modifications of LC element.
[Drawing 18] It is drawing showing other modifications of LC element.
[Drawing 19] It is drawing showing the partial modification of the cross-section structure of LC element shown in drawing 15 .
[Drawing 20] It is drawing showing the partial modification of the cross-section structure of LC element shown in drawing 15 .
[Drawing 21] It is drawing showing other modifications of LC element.
[Drawing 22] the inductor which has a meandering configuration -- it is drawing for explaining operation of a conductor
[Drawing 23] It is drawing showing other modifications of LC element.
[Drawing 24] It is drawing showing other modifications of LC element.
[Drawing 25] It is drawing showing other modifications of LC element.
[Drawing 26] It is drawing showing other modifications of LC element.
[Drawing 27] It is drawing showing other modifications of LC element.
[Drawing 28] It is drawing showing other modifications of LC element.
[Drawing 29] It is the A-A line expanded sectional view of drawing 28 .
[Drawing 30] It is the B-B line expanded sectional view of drawing 28 .

[Drawing 31] It is the C-C line expanded sectional view of drawing 28 .
[Drawing 32] It is drawing for explaining the state where a channel is formed in LC element shown in drawing 28 .
[Drawing 33] It is drawing showing the cross section which met the electrode of the shape of spiral shape of LC element shown in drawing 28 .
[Drawing 34] It is drawing showing the equal circuit of LC element shown in drawing 28 .
[Drawing 35] It is drawing showing the manufacturing process of LC element shown in drawing 28 .
[Drawing 36] It is drawing showing other modifications of LC element.
[Drawing 37] It is drawing showing other modifications of LC element.
[Drawing 38] It is drawing showing other modifications of LC element.
[Drawing 39] It is drawing showing other modifications of LC element.
[Drawing 40] It is drawing showing other modifications of LC element.
[Drawing 41] It is drawing showing other modifications of LC element.
[Drawing 42] It is drawing showing other modifications of LC element.
[Drawing 43] It is drawing showing other modifications of LC element.
[Drawing 44] It is the A-A line expanded sectional view of drawing 43 .
[Drawing 45] It is the B-B line expanded sectional view of drawing 43 .
[Drawing 46] It is the C-C line expanded sectional view of drawing 43 .
[Drawing 47] It is the D-D line expanded sectional view of drawing 43 .
[Drawing 48] It is drawing showing the equal circuit of LC element shown in drawing 43 .
[Drawing 49] It is drawing showing the partial modification of an I/O electrode prepared in the edge.
[Drawing 50] It is drawing showing other modifications of LC element.
[Drawing 51] It is drawing showing other modifications of LC element.
[Drawing 52] It is drawing showing other modifications of LC element.
[Drawing 53] It is drawing showing other modifications of LC element.
[Drawing 54] It is drawing showing other modifications of LC element.
[Drawing 55] It is drawing showing the partial modification of the cross-section structure of LC element shown in drawing 43 .
[Drawing 56] It is drawing showing other modifications of LC element.
[Drawing 57] It is drawing for explaining the state where a channel is formed in LC element shown in drawing 56 .
[Drawing 58] It is drawing showing other modifications of LC element.
[Drawing 59] It is drawing showing other modifications of LC element.
[Drawing 60] It is drawing showing other modifications of LC element.
[Drawing 61] It is drawing showing other modifications of LC element.
[Drawing 62] It is drawing showing other modifications of LC element.
[Drawing 63] It is drawing showing the partial modification of the cross-section structure of LC element shown in drawing 56 .
[Drawing 64] It is drawing showing the partial modification of the cross-section structure of LC element shown in drawing 56 .
[Drawing 65] It is drawing showing other modifications of LC element.
[Drawing 66] It is drawing showing other modifications of LC element.
[Drawing 67] It is drawing showing other modifications of LC element.
[Drawing 68] It is drawing showing other modifications of LC element.

[Drawing 69] It is drawing showing other modifications of LC element.
[Drawing 70] It is drawing showing other modifications of LC element.
[Drawing 71] It is drawing showing other modifications of LC element.
[Drawing 72] It is drawing showing other modifications of LC element.
[Drawing 73] It is drawing showing other modifications of LC element.
[Drawing 74] It is drawing showing other modifications of LC element.
[Drawing 75] It is drawing showing other modifications of LC element.
[Drawing 76] It is drawing showing other modifications of LC element.
[Drawing 77] It is drawing showing the outline of other modifications of LC element.
[Drawing 78] It is drawing showing an example of the manufacturing process of LC element shown in drawing 77 .
[Drawing 79] It is the plan of LC element shown in drawing 77 .
[Drawing 80] It is drawing showing other examples of the manufacturing process of LC element shown in drawing 77 .
[Description of Notations]
1 Sinusoidal Oscillator Circuit
10 Inverter Logical Circuit
12 LC Element
16 Capacitor
20 1st Spiral Electrode
22 2nd Spiral Electrode
24, 26, 28 I/O electrode
34 P-Si Substrate (P-Type-Silicon Substrate)
36 Pn Junction Layer